TURRETS..

SECTION (15)

CONTENTS

Part I—Frazer Nash Turrets
Part II—Bristol Turrets
Part III—Boulton Paul Turrets

https://ww2aircraft.net/

https://ww2aircraft.net/

POWER OPERATED TURRETS

SUMMARY

Part I.—Frazer Nash Turrets.
Part II.—Bristol Turrets.
Part III.—Boulton Paul.

General Introduction

1. Increasing speeds of modern aircraft make it impossible for an air gunner to train a free gun or guns against the pressure of the air stream. To overcome this difficulty, power operated turrets have been introduced to protect the air gunner from the air stream and to provide power for training the gun or guns.

Power Supply

2. Hydraulics is the science of liquids in motion. Application of the principles of hydraulics to the gun turret imposes the following restrictions on the type of oil used:—

(*a*) It must flow freely.
(*b*) It must be non-corrosive.
(*c*) It must be non-injurious to washers.
(*d*) It must be non-freezing.

3. As oil is a liquid it—

(*a*) Will not compress, i.e., it cannot change its volume under pressure.
(*b*) Will expand and contract with increase and decrease of temperature.
(*c*) Will transmit applied pressures through it equally and undiminished in all directions.

4. The pressure of the oil is capable of overcoming opposing resistances.

5. The flow of oil governs the speed of movement, so the speed of the turret is controlled by the size of the holes through which the oil has to pass.

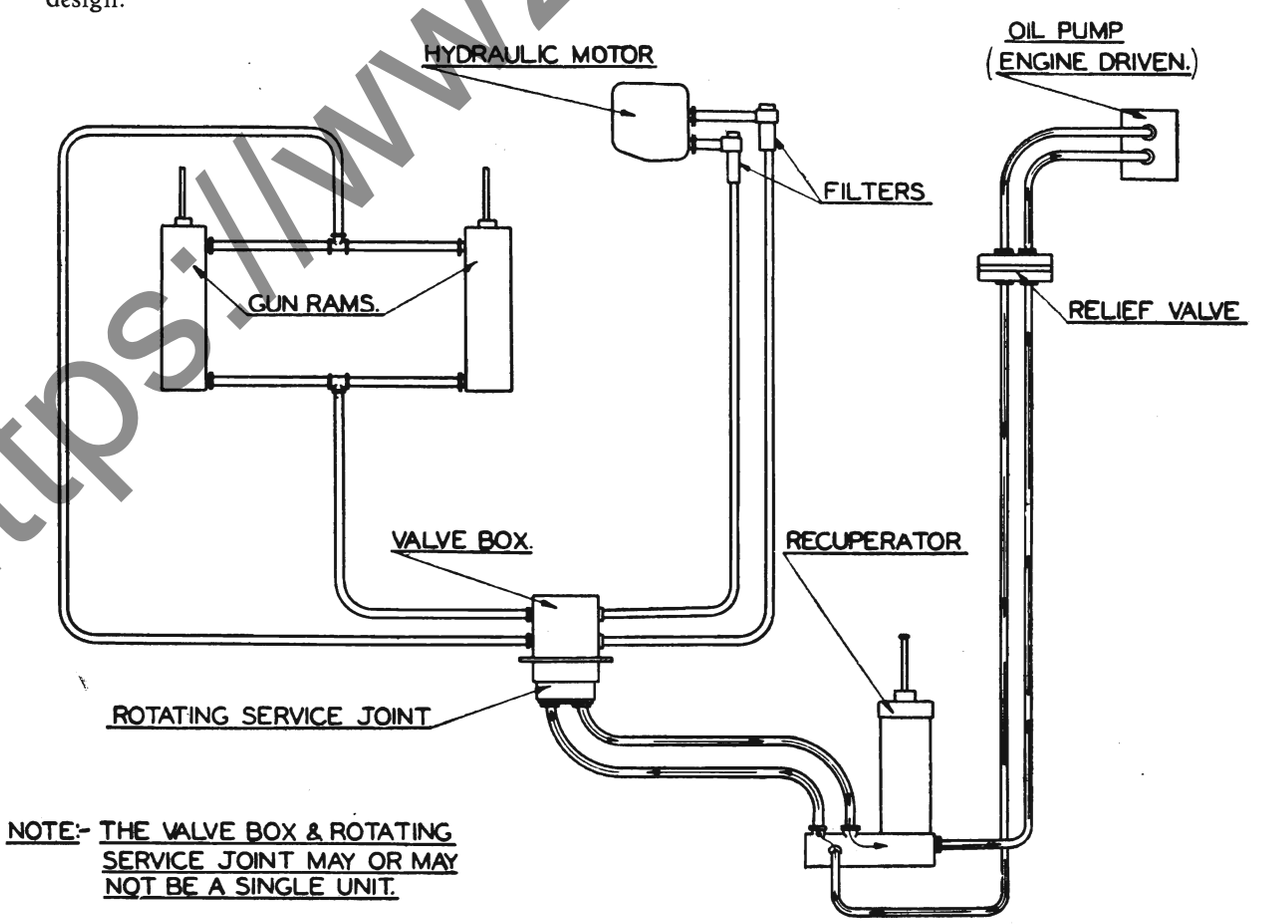
6. As air is detrimental to any hydraulic system, provision is made at various points to bleed the air from the system.

7. There are several types of power operated turrets used in the Service. They will be described in the following chapters.

PART I—FRAZER NASH GUN TURRETS

Introduction

8. (*a*) There are various types of the Frazer Nash gun turrets which differ in arrangement according to the position of mounting in the aircraft, and in fire power; but all are similar in general design.



LAYOUT OF SYSTEM.

https://www.2aircraft.net/

(*b*) Frazer Nash gun turrets may be divided into two main classes:—

(i) Partially rotating: Nose and tail turrets.

(ii) Fully rotating: Mid-upper or mid-under turrets which in some cases can be extended or lowered to improve the field of fire.

Mid-upper turrets are fitted with a gun-firing cutout device to prevent damage to the aircraft when the field of fire is passing over the main plane or tail units, and a gun depression limiting device which allows the guns to be fully depressed only when the turret is rotated to the port or starboard beam for firing.

(*c*) Armour plate has been fitted to some turrets as protection for the air gunner.

(*d*) The system is hydraulic. Motive power is supplied by an engine-driven pump.

(*e*) Each turret has its own independent oil circulation system.

(*f*) All Frazer Nash gun turrets are based on a common range of components (with a few exceptions), so that a knowledge of one turret enables most types to be dealt with.

GENERAL DESCRIPTION OF COMPONENT PARTS AND THEIR FUNCTIONS

Engine-driven Gear Pump

9. (*a*) This is a gear type pump (Beacham pattern). It is mounted on the aircraft engine.

(*b*) Within the pump body are two gears—

(i) The driving gear, connected by a shaft to the engine.

(ii) Driven or idler gear which is meshed with the driving gear.

(*c*) Both gears rotate in a close fitting casing which has two opposite ports located at the point of mesh of the two gears. The oil is carried round between the tooth-gaps of the gears and the bore until it reaches the outlet port where it is expelled by the displacement due to the teeth of the gears re-engaging.

(*d*) The pump discharges about 6 to 8 gallons of oil per minute at a working pressure of approximately 300 lbs. per sq. inch.

(*e*) When stationary, oil cannot pass through the pump.

(*f*) There is one pump to each turret circuit. Pumps may be either single or double. The double type is contained within one body, but serve each turret separately.

(*g*) The pump shaft is under-cut, so that if the pump seizes the shaft will shear. This prevents damage to the engine.

(*h*) The pump shaft rotates on ball bearings. Oil sealing washers are fitted to prevent leakage of oil.

(*i*) The engine-driven gear pump supplies the necessary pressure oil to operate the gun turret and its components.

Oil Pipe Lines

10. (*a*) The pressure pipe delivers oil from the outlet or exhaust port of the gear pump to the turret.

(*b*) The exhaust pipe returns oil from the turret to the inlet or suction port of the gear pump.

(*c*) The pipes are fitted in sections joined together by union nuts, adaptors, and solderless nipples.

(*d*) In the case of mid-upper and mid-under retracting turrets, and also in the Sunderland horizontal nose retracting turret, the pipes are fitted with articulated couplings to allow for movement.

(*e*) In most turret systems the pressure pipe is of smaller diameter than the exhaust pipe.

(*f*) The maximum working pressure is 350 lbs. per sq. inch. Maximum working pressure in the exhaust pipe is approximately 20 lbs. per sq. inch.

(*g*) The oil pipe lines are made of a brass alloy, union nuts and adaptors are drilled for provision of a locking wire.

The Recuperator

11. (*a*) The recuperator consists of three main parts:—

(i) Cylinder and piston assembly.

(ii) Hand pump.

(iii) Base block and release valve.

(*b*) The cylinder is made of duralumin. It is divided into an upper and lower chamber by a fixed piston located by a tube and anchored to a cap which seals the top chamber. The top chamber is fitted with a filling plug.

In the lower chamber is a sliding piston to which is attached a plunger rod extending through the tube and gland fitted to the cap.

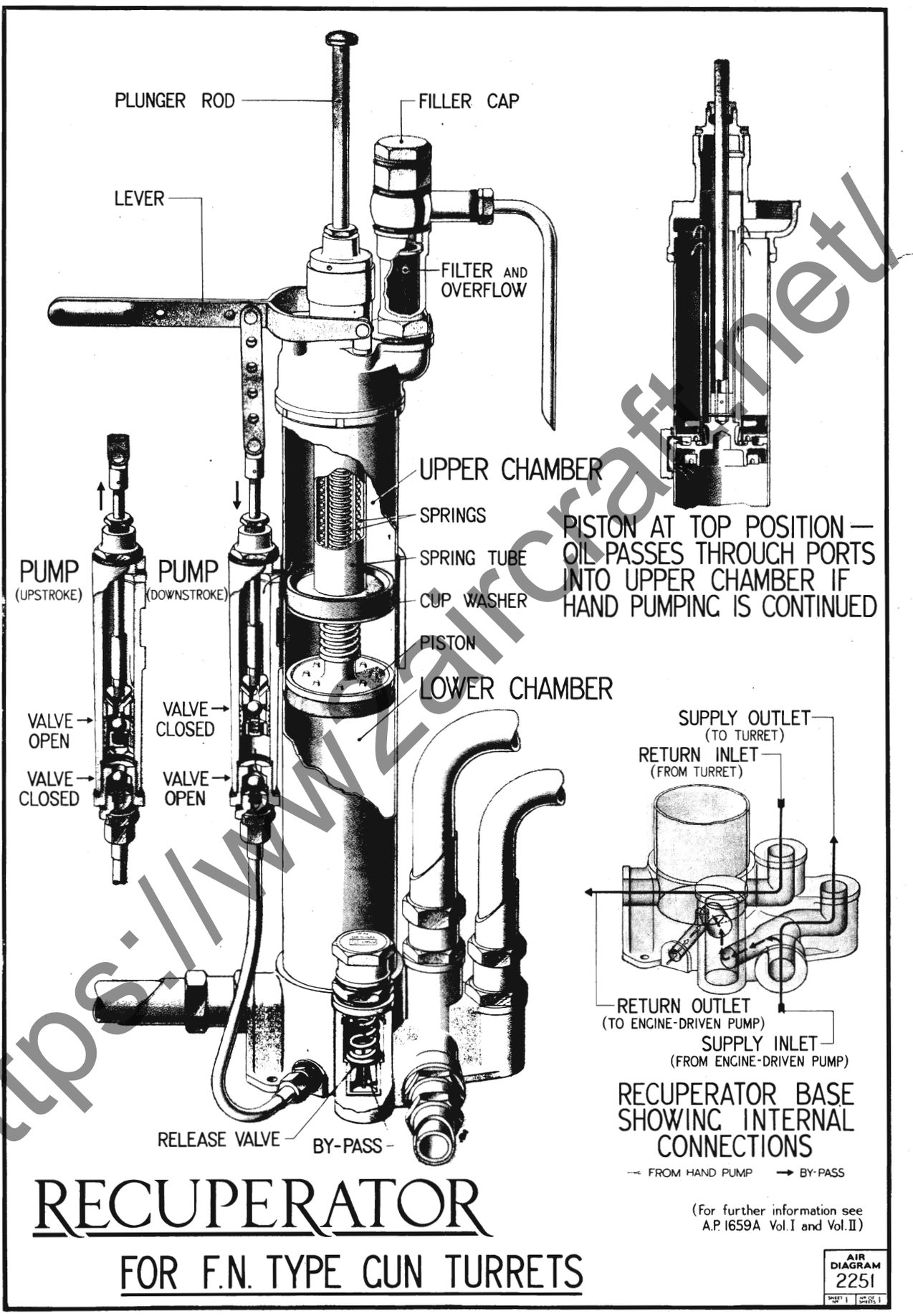
This piston is spring loaded by two springs, right- and left-hand coils. to prevent jamming.

In the cylinder wall, near the top of the lower chamber, are drilled two holes connecting to a transfer port formed in the hand pump casting.

(*c*) The hand pump is a hand-operated pump of the single plunger type, fitted with two spring loaded non-return valves.

The body of the pump is mounted on the side of the recuperator and is in communication with the upper chamber.

https://ww2aircraft.net/



RECUPERATOR

FOR F.N. TYPE GUN TURRETS

(For further information see A.P. 1659A Vol. I and Vol. II)

AIR DIAGRAM 2251

https://www.aircraft.net/

Oil under gravity, plus the vacuum created by the up-stroke of the pump, operates the toy valve to open it. The down-stroke returns the valve on to its seating. The oil under the plunger opens the bottom non-return valve and the oil is transmitted to the bottom chamber of the recuperator by a small pipe line. When the plunger is on the up-stroke, the bottom non-return valve is returned on to its seating by the spring.

(*d*) The base block and release valve are fitted to the base of the recuperator cylinder.

There are four connections fitted to the base block, two of which are connected to the exhaust pipe line and connect with the lower chamber of the recuperator. The other two connect with the pressure pipe line, but do not connect with the lower chamber.

The release valve is fitted into the base block and connects the pressure line with the exhaust line. Should the oil pressure become excessive in the pressure line, the spring loaded release valve will rise and allow the excess oil to by-pass into the exhaust line.

(*e*) Functions of the Recuperator.

(i) To act as a chamber of variable volume introduced into the circuit to compensate for differences of volume due to ram extension and, in a lesser degree, temperature variation.

(ii) To maintain at all times a low pressure of between 16 and 20 lbs. per sq. inch.

a. When the engine is running a pressure is kept on the exhaust side of the system thus preventing starvation of oil at the inlet or suction side of the pump.

b. When the engine is stationary a pressure is kept on the whole system to keep all washers expanded, thus preventing oil leakage.

(iii) To provide a reserve supply of oil to make good any loss which may occur over a period of time.

(iv) It is a means of filling the system without exposing the system to the air. By operating the hand pump, oil is transferred to the bottom chamber while the top chamber is replenished with oil.

(v) It is a means of bleeding out air trapped under the recuperator piston, i.e., if the piston is pumped up to its fullest extent, air will escape through the transfer port to the top chamber.

(vi) The release valve, housed in the recuperator base, by-passes any excess oil from the pressure line to the exhaust line.

The Relief Valve

12. (*a*) The relief valve body houses a spring loaded poppet valve. The spring is held in place and can be adjusted by a screwed cap. Through the main body are drilled two oilways which connect with the pressure and exhaust lines. Usually the relief valve is fitted near the engine-driven pump, but in some cases it is fitted near the turret.

(*b*) Functions of the Relief Valve.

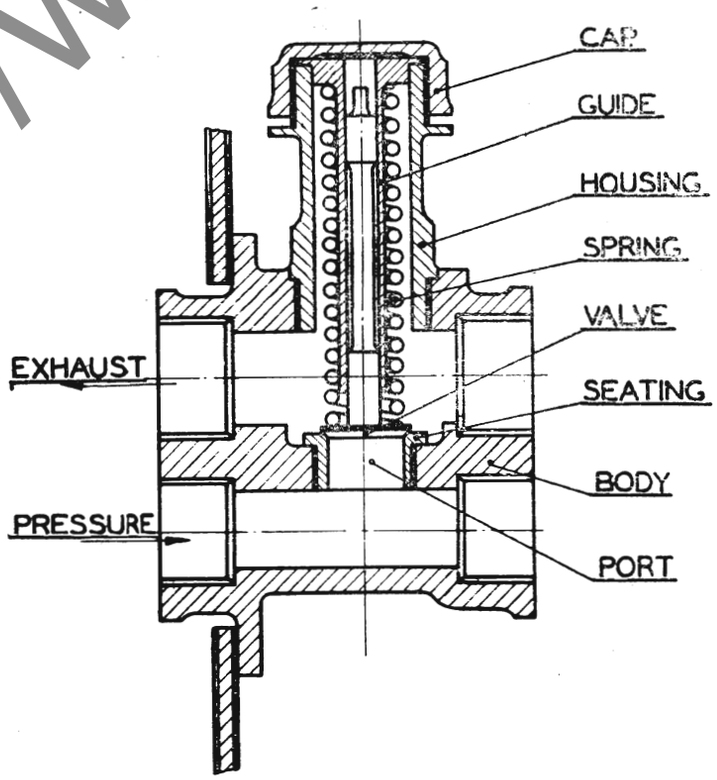
This valve is a means of by-passing oil from the pressure line to the exhaust line in order to prevent damage to the system—

a. In the event of a blockage in the system.

b. When the turret and/or the gun rams have operated to their limit.

c. When the master valve is operated and the elevation and rotation valves are in their neutral position.

(*c*) The release and relief valves serve the same purpose in by-passing oil from the pressure to the exhaust. Should one valve be unable to cope with the flow of oil, the other will assist. In some systems a second relief valve is fitted in the circuit.



RELIEF VALVE.

https://www.2aircraft.net/

The Rotating Service Joint

13. (*a*) This consists of two portions:—

(i) A fixed portion which is fitted to the air-frame.

(ii) A rotating portion which is attached to the rotating frame of the turret.

(*b*) The rotating service joint (R.S.J.) is mounted on ball races to allow free movement. The outer casting has two passages which connect with the pressure and exhaust pipe lines. The inner portion consists of two tubes in which holes are drilled registering with the passages in the outer casting by means of which oil is conveyed from the fixed to the rotating portion.

(*c*) Oil seals are fitted at top and bottom to prevent oil leaking out.

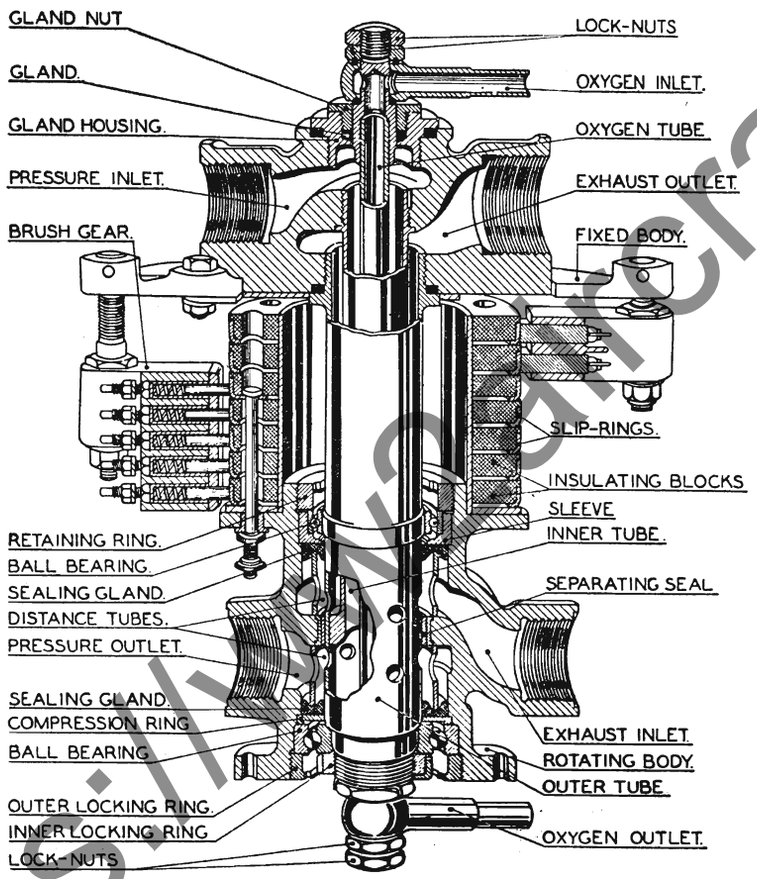
(*d*) A white-metal bearing is fitted in the rotating body between the pressure and exhaust passages, and is in close working fit around the outer sleeve to prevent the pressure oil from leaking into the return line.

(*e*) When the R.S.J. is fitted to the top of the turret it is called "a top entry," when fitted to the bottom it is called "a bottom entry."

(*f*) The R.S.J. does not support any weight of the turret.

(*g*) The function of the rotating service joint is to supply an unlimited amount of pressure oil to the turret and to return the exhaust oil from the turret to the return line. At the same time it allows the turret to rotate.

(*h*) Provision is made in most R.S.J.'s for oxygen and electric supply connections to enter the turret through the R.S.J.



ROTATING SERVICE JOINT.

The Turret Assembly

14. (*a*) The complete turret is mounted on a rotating ring and moves on ball races in an outer or fixed ring attached to the airframe. A circular gear rack is attached to the inside of the fixed ring, which is drilled to receive bolts for attachment to the airframe, and provides a smooth track for the equally spaced vertical, and horizontal ball races, carried on the rotating ring fixed to the turret. The vertical ball races take the weight of the turret and air gunner; the horizontal ball races take the thrust, gun recoil and air loads on the turret cupola.

(*b*) The cupola is a light metal framework fitted with moulded transparent panels (perspex), so that the air gunner has both protection from the air stream and vision to observe the target. Slots or shutters are provided in the cupola to allow for elevation and depression of the guns.

(*c*) Rear turrets are provided with doors in the cupola; front and mid-upper turrets are usually entered from underneath; whilst mid-under turrets are entered from the top of the turret.

(*d*) Contained within the turret assembly is the valve box, rotation motor, gun elevation rams, valve box control handles, Palmer hydraulic gun firing mechanism, air gunner's seat, ammunition bins, gun platform or cradle and supports, guns, link and ammunition chutes, sight arm and sight, hand rotation gear, turret rotation lock, drift scale indicator (rear turrets), switches for lights and gun sight, wiring for intercommunication, etc.

https://www.aircraft.net/

(*e*) Nose and rear turrets are provided with a rotation stop gear to limit the turret rotation. This arrangement is operated by either a fixed stop engaging a lever and shock absorber, or by a fixed stop engaging a lever and Bowden cable to centralize the control handle and rotation valve.

The Valve Box

15. (*a*) This box contains the master valve and rotation and elevation valve, housed in a single casting which has necessary passages and ports drilled for communication between the valves and slave units, the oil pressure, and exhaust system.

(*b*) The master valve either supplies or denies oil to the rotation or elevation valves which, in turn, distribute oil to the slave units. Movement of the master valve is $\frac{3}{8}$ inch. Movement of the elevation and rotation valves is $\frac{3}{16}$ inch either side of the centralized position, i.e., $\frac{3}{8}$ inch total travel.

(*c*) There are two types of valve boxes:—

(i) Triangular.

(ii) Three valves in line.

(*d*) The master valve, rotation valve and elevation valve are the dumbbell type of piston valve.

The Poppet Valve

16. (*a*) A poppet valve is fitted to the triangular valve box. When the master valve is operated it raises the valve so that, when the elevation valve is operated, the exhaust oil from the bottom of the gun ram can pass the poppet valve and return to the exhaust line. When the master valve is released the poppet valve is returned to its seating by a spring, thus preventing the gun from sinking.

(*b*) The three in line valve box is fitted with a non-return valve banjo which has two spring loaded valves to prevent the guns from sinking.

The Control Handles

17. (*a*) Situated on the control handles are the master valve levers which, when depressed, operate the master valve through a linkage of rods and levers.

(*b*) By twisting the handles backwards and forwards, the elevation valve is operated.

(*c*) By turning the handles to the right or left, the rotation valve is operated.

(*d*) Attached to the control handles are two trigger levers which, when depressed, operate the control valve of the hydraulic gun-firing mechanism.

(*e*) The controls may be operated with both hands or with either the left or right hand.

The Vane Oil Motor

18. (*a*) This motor consists of a body, stator sleeve and end covers, rotor with vanes, pins, side plates, shaft, spindle and pinion gear.

(*b*) It is a motor of the sliding vane type.

(*c*) The stator has a series of holes, so arranged that the sleeve interior is put in communication with channels cut in the bore of the body. These channels communicate with two pipes leading to the rotation valve.

(*d*) In the slots of the rotor are fitted six sliding steel vanes or blades kept at a fixed distance apart by three pins passing through connecting holes.

(*e*) The working surface of the sleeve is that portion between the two ports which are in communication with the rotation valve. The faces of the vanes are accurately ground to ensure that the oil will not work back past the vanes.

(*f*) The clearance between the vanes and the working surface is 0·00025 inch, the clearance between the vanes and the non-working surface of the sleeve is 0·040 inch.

(*g*) The rotor is fitted eccentrically to the stator sleeve so that the vanes project approximately $\frac{1}{4}$ inch on the working side and are flush with the rotor on the opposite side.

(*h*) The rotor shaft rotates on ball bearings, a double race on the pinion end, a single race on the inner end.

(*i*) The motor is attached to the turret structure and the pinion engages with the circular rack so that, as the pinion turns and the rack is fixed, the turret must rotate due to reaction.

(*j*) Oil is prevented from leaking from the motor by the fitment of oil sealing washers.

(*k*) Points concerning the Rotation Motor.

(i) The direction of rotation will vary according to which side of the motor the pressure oil is provided.

(ii) If the rotation valve is operated, pressure oil will be supplied to one side of the motor. The oil acting on the extended vane, because of the larger area, will rotate the motor. After the vane has passed the working surface it begins to recede into the rotor body, because of the eccentric mounting of the rotor; the pressure oil, now having served its purpose, is exhausted into the return system.

(iii) Filters are fitted to both connections of the rotation motor. As the flow of oil is reversible, they are self-cleaning and do not have to be removed.

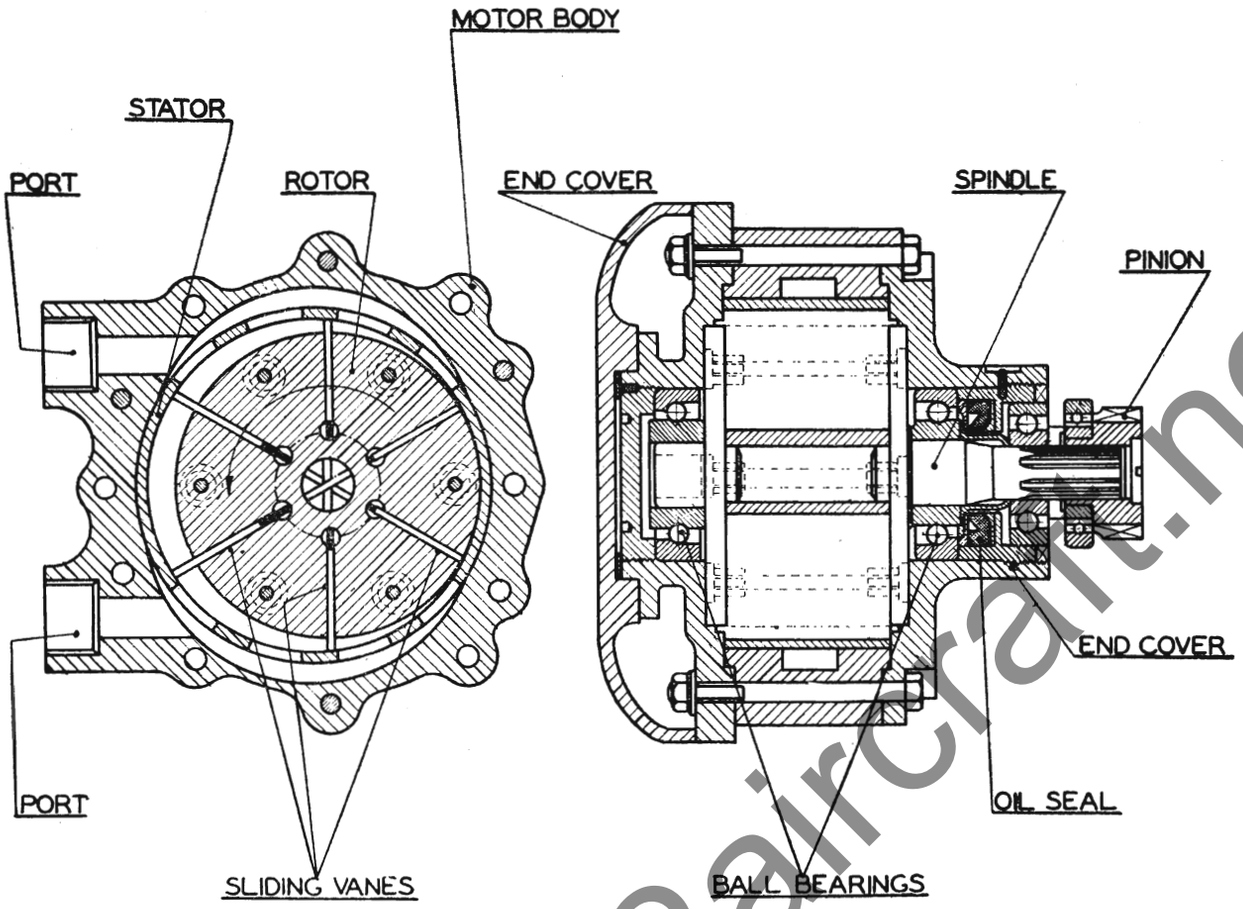
(iv) The rotation motor requires about 4 gallons per minute oil flow for speed of 350 revolutions per minute.

(v) The approximate ratio between the rotation pinion gear and the turret gear ring is 35 : 1.

https://www.2aircraft.net/

(vi) In some turrets dual rotation motors are fitted to improve the speed and to overcome the increased air pressure on the turret and gun barrels.

(vii) In some systems an external rotation valve is fitted near the rear turret so that the turret can be operated from the outside to enable doors to be opened in the case of the removal of a casualty air gunner.



VANE OIL MOTOR.

The Hand Rotation Gear

19. (*a*) This gear is fitted to some rotation motors to enable the air gunner to rotate the turret by hand.

(*b*) The keyed shaft of the hand rotation gear engages with a keyed sleeve attached to the rotation motor, so that the rotational movement of the handle is transmitted to the pinion and rack. In some types of turret the hand rotation pinion engages directly with the gear rack of the fixed ring.

(*c*) When the hand rotation gear is operated manually, the controls should be moved to the right and left alternately to prevent the rotation motor being drained or the admission of air due to the suction caused by operating the turret manually.

The Rotation Lock

20. (*a*) This lock is fitted to most turrets to enable the air gunner to lock the turret on the fore-and-aft centre line of the aircraft.

(*b*) A plunger is mounted on the turret and engages with a recess in the fixed ring to lock the turret. The plunger can be drawn from the recess to free the turret.

Gun Elevation Rams

21. (*a*) There may be one or more gun elevation rams fitted to a turret.

(*b*) The hydraulic ram consists of a cylinder containing a double acting piston attached to a hollow piston rod which is coupled to the gun arm or cradle.

(*c*) Oil sealing washers are fitted to prevent loss of oil. Pipe connections are fitted to the top and bottom of the cylinder.

(*d*) When the controls are operated for elevation or depression, oil enters and exerts pressure on one side of the piston, moving it up or down. Oil on the other side of the piston is returned to the exhaust side of the system.

(*e*) A bleed screw is provided at the top of the hollow piston rod to release any air trapped underneath the ram. A second bleed screw is provided at the top of the ram cylinder to release any air trapped on top of the ram.

(*f*) The piston rod may be fitted with a sleeve or an adjusting nut and lock-nut to limit the gun ram travel.

(*g*) The ram is double-acting, so that it is automatically locked when the supply oil is cut off.

https://ww2aircraft.net/

The Palmer Gun Firing Mechanism

22. This mechanism is dealt with fully under the heading "Gun Firing Mechanisms ·303-in. Browning."

The Vokes Filter

23. (*a*) This is fitted in the return line, between the turret and the engine-driven pump. The return or exhaust oil enters the centre of the filter element, the pump draws oil through the filter element which consists of a perforated cylinder, wire gauze and flannelette material.

(*b*) It is possible that a choked filter may cause runaway guns, sluggish turrets, etc., therefore should be cleaned in petrol during inspections.

(*c*) Nevertheless it is most unlikely that a choked filter will interfere with the functioning of the turret, as the filter cylinder is spring loaded in its outer casing. If the filter becomes choked the pressure of oil will depress the cylinder and allow the oil to by-pass over the top of the filter.

(*d*) After removal of the outer casing to clean the filters care should be taken to tighten the clamp ring bolts evenly on re-assembling to avoid distortion or breakage as the ring is of light and fragile material.

Filling and Bleeding

24. (*a*) The oil used is oil, lubricating, anti-freezing, Type A (Stores Ref. 34A/43 or 46) ensure that the oil is filtered and clean as foreign matter in the fluid will cause irreparable damage to the hydraulic components.

(*b*) The method of filling the system is as follows:—

(i) Close the gun elevating rams.

(ii) Slacken off the union nuts and disconnect the inlet and outlet pipes of the engine-driven pump.

(iii) Remove the filler cap on the recuperator. Fill the recuperator reservoir through a gauze filter, working the hand recuperator pump at the same time.

NOTE.—Do not pump too quickly or the oil in the reservoir will be exhausted and air will be pumped into the system.

(iv) Continue filling and pumping until oil appears at the inlet pipe union of the pump. Then connect the pipe and tighten the union.

(v) Continue filling and pumping until oil appears at the outlet pipe union of the pump. Then connect the pipe and tighten the union.

(vi) Pump up the recuperator until the plunger rod is fully extended. Continue pumping for 30 seconds to displace any air which may be trapped under the plunger piston.

(vii) Operate the master valve and control valves to fill the hydraulic components and pipes.

(*c*) The turret is now ready for bleeding, an operation necessary to expel any air which may be trapped at the bottom and top of the gun elevation rams, within the rotation motor or in the system.

The method of bleeding is as follows:—

(i) Slacken off the bleed screw at the top of the gun elevation ram body. With the master valve depressed, operate the elevation valve for ram extension. When clear oil appears, tighten the bleed screw.

(ii) Slacken off the bleed screw on the end of the ram piston rod. With the master valve depressed, operate the elevation valve for ram retraction. When clear oil appears, tighten the bleed screw.

(iii) Check the recuperator plunger height, and if it is too low, pump until the plunger extends 4 inches.

(iv) Start the engine-driven pump and run it at the maximum permissible speed.

(v) Repeat the operations described in sub-paras (i) and (ii).

(vi) Operate the turret in both rotation and elevation to displace all air in the system and cause it to accumulate under the recuperator plunger piston rod.

(vii) Pump up the recuperator to its fullest extent and continue pumping until all air has been displaced through the filling hole. Then completely fill the reservoir.

(viii) Bleed air from rear sear release hydraulic rams by means of the bleed screws provided.

(ix) With the gun rams fully closed drain the system until the recuperator plunger extends 4 inches. It is advisable that one man should drain the system and another should watch the recuperator plunger. Three alternative ways of draining the system to obtain the requisite recuperator plunger height are given below:—

a. Detach a rear sear release hydraulic ram from the gun, slacken off its bleed screw and drain into a container. Tighten the bleed screw when the recuperator plunger has dropped to the correct height, and attach the rear sear release ram to the gun.

b. Screw the special draining adaptor, supplied with the tool kit, into the pressure gauge coupling in the exhaust pipe. Drain off the oil until the recuperator plunger has dropped to the correct height. Then unscrew the draining adaptor from the gauge coupling.

c. When the recuperator is mounted in a position where communication with the man watching the recuperator is difficult, drain off one-third of a pint of oil either at the rear sear release unit as described in para. a. or at the pressure gauge coupling as described in para. b.

(x) After the operation described in sub-para. (ix) has been performed, an air space of approximately 1 inch will be left in the recuperator reservoir. Do not add any more oil. Replace the cap on the recuperator filler.

https://ww2aircraft.net/

Checking the Oil Level—Topping Up the System

25. (*a*) The amount of oil in the lower chamber of the recuperator is indicated by the position of the plunger which extends through the top of the recuperator. To check the oil level, the rams must be closed. Under these conditions, the recuperator plunger will extend 4 inches if the system is full. If the plunger extension is less than 4 inches, operate the recuperator hand pump until the correct extension is obtained. Should the plunger fail to rise when the recuperator hand pump is operated, it will indicate that the recuperator reservoir is empty. The system then requires topping-up in the following manner:—

(i) See that the rams are fully closed.

(ii) Remove the recuperator filler plug, fill up the recuperator reservoir, at the same time work the recuperator hand pump.

(iii) Continue pumping until the plunger is fully extended.

(iv) Repeat the operations as described in para. 24, sub-para. (*c*) (ix) and (x).

(*b*) If the reservoir is completely filled with oil when the plunger is fully extended, the system will be overfilled and excessive pressure will cause the system to burst or cause runaway guns. However, a recent modification, viz., drilling a hole in the filler cap of the recuperator, allows any excessive pressure or excess oil to escape, thus preventing damage to the system and removing the possibility of runaway guns.

NOTE.—For filling and bleeding instructions for retracting turrets, see relevant chapters of A.P.1659A, Volume I.

MECHANISM AND OPERATION OF THE TURRET

26. After the turret system has been completely and correctly filled with oil, air expelled from the various bleed points in the system, and the plunger of the recuperator extended approximately 4 inches, the system is ready for operation.

27. Upon starting the engine, the gear pump will circulate oil along the pressure pipe, round the undercut portion of the dumb-bell master valve, then into the return pipe through the Vokes filter and back to the pump.

28. The spring pressure on the recuperator piston keeps a pressure between 16 and 18 lbs. per sq. inch on the return oil to assist the feed of the pump.

29. On operation of the master valve, the oil is diverted to the rotation and elevation valves. If these valves are centralized, pressure will be built up in the pressure line until approximately 300 lbs. per sq. inch is reached. Then the release and/or relief valve will open, allowing the excess pressure oil to return into the return line. So there will be approximately 300 lbs. per sq. inch in the pressure line and valve box and between 16 and 20 lbs. per sq. inch in the return line.

30. On operation of the rotation valve, pressure oil will be transmitted to the rotation motor and rotate the turret. Likewise, if the elevation valve is operated, oil will be transmitted to the gun rams which will elevate the guns.

31. Both the elevation and rotation valves may be operated at the same time, so that the turret may be rotated and the guns elevated or depressed simultaneously. The exhaust oil from the rotation motor and rams returns through passages in the valve box to the return line.

32. A tapping from the pressure line supplies pressure oil to the accumulator, so that when the gun firing control valve is operated, the pressure oil will fire the guns.

33. On releasing the master valve levers, the master valve returns to its normal position, blanking off the pressure oil from the rotation and elevation valves. The pressure oil flows round the cut-away portion of the master valve and returns along the exhaust line to the pump.

34. In the event of the turret rotating to its limit, or the guns elevating or depressing to their full extent, the pressure built up in the pressure line will be exhausted through the release and/or relief valves. As the guns are depressed, or elevated, a linkage attached to the gun platform or cradle moves a sight arm and sight, but maintains the line of sight parallel to the axis of the gun.

35. With retracting turrets, retraction rams are used to raise and lower the turret; these are used in conjunction with a shunt valve, retraction valve and change-over valve. An emergency retraction hand pump is also used.

36. In some turrets, where armour plate is used. auxiliary hydraulic rams are used to assist the gun elevation rams because of the extra weight which arises.

37. With mid-upper turrets, a gun trip mechanism is fitted and so designed to automatically cut off the flow of oil to the gun elevation rams and rotation motor whenever the air gunner attempts to depress the guns into areas where projections of the aeroplane would intercept the field of fire, at certain sections of the turret rotation. A gun firing cut-out mechanism is also provided to safeguard the high projections of the aeroplane and is so arranged that it automatically cuts out the gun fire at sections of the turret rotation where these projections would intercept the field of fire. This only occurs when the guns are depressed below a predetermined elevation.

THE SERVO-FEED TURRET

38. This turret was designed to carry more ammunition at a single loading and to keep the centre of gravity of the aircraft and the weight of the rounds as near together as possible, i.e., to throw the main weight of the rounds near the trailing edge of the main planes.

39. The ammunition tanks in the turret are connected to the turret by ammunition chutes which convey the four belts to a point on each side of the rotating service joint at the base of the turret.

40. The servo-feed mechanism consists of a clutch, sprockets and vane oil motor, and is so arranged inside the turrets that when the guns are fired the servo-feed sprockets rotate, drawing the ammunition belts from the chutes and assist in the belt-feed to the guns.

https://ww2aircraft.net/

CARE AND MAINTENANCE

41. Instructions for dismantling and assembling, testing and repair are to be found in A.P. 1659A, Volume II.

42. All working parts of the turret should be kept free from rust and corrosion. They should be lubricated with oil, lubricating, anti-freezing, Type A and grease, anti-freezing. A lubrication chart will be found for each turret in A.P. 1659A, Volume I.

43. The transparent panels of the cupola should be kept clean and free from scratches. The gun sight (prismatic, reflector or gyro) should be tested and cleaned before use.

44. During flight, especially when low temperatures are experienced, the turret should be operated from time to time to ensure that the oil in the turret components does not congeal and so render the turret sluggish in operation.

45. Before use, expel air from under the recuperator piston and at the various bleed screws in the system. The recuperator plunger should extend approximately 4 inches.

46. Inspect the turret and components for damage and leaks. Inspect the pipe lines for leakage, especially the flexible pipe connections to the engine-driven pump and rear sear release units.

47. Examine all controls and mechanisms for correct adjustment and functioning.

48. The gun firing Bowden cables should be inspected for security, lubricaton and correct adjustment.

49. Inspect guns, attachments, mountings, ammunition boxes, feed rollers and chutes, etc., for security and correct functioning. Before flight ammunition should be checked for cleanliness, type and quantity.

50. Check harmonization of guns and sight. Test electric connections, intercommunication system, oxygen supply, etc. Ensure that the necessary tools are in their correct stowage.

FAULTY FUNCTIONING OF THE TURRETS

51. Uncontrolled movement of guns, irregular movement of turret, noise in the system and gear pump are usually due to the presence of air in the system.
Remedy: Bleed air from the system and top-up.

52. Runaway guns, when the guns are depressed, are usually caused by an over-filled system.
Remedy: Bleed and fill correctly.

53. Sluggish turrets and runaway guns may be caused by a blockage in the system or a choked Vokes filter.
Remedy: Remove blockage or clean Vokes filter.

54. Runaway guns may be caused by incorrect adjustment of the gun firing Bowden cables, seizure of the Bowden cables, gun firing control valve, trigger levers or broken control valve return spring.
Remedy: Readjust cables, free and lubricate faulty parts, replace spring.

55. Noise in the system or pump may be caused by the gland nut of the recuperator being tightened too firmly. This would not allow the piston to keep a pressure on the return line, thus causing cavitation of the gear teeth or the pump starving for oil.
Remedy: Free gland nut and packing; the gland nut should be only finger tight.

56. Noise in the gear pump may be caused by worn teeth, ball races or shaft.
Remedy: Replace the pump.

57. It may be found that where a dual pump is fitted, one turret system loses oil while the other turret system gains oil.
Remedy: Replace pump (oil is passing the oil retaining washers between the two pumps).

58. Oil may leak from the system owing to the deterioration of the oil sealing washers or packings. Oil may leak from unions and connections in the system.
Remedy: Replace the washers, etc., tighten unions, connections, etc.

59. Stoppages with guns fitted in turrets may be caused by full deflector bags or containers, links jammed in the link chutes, or the ammunition belt being caught in the shute or feed rollers.
Remedy: Empty containers, free chutes.

60. Guns fail to fire. This may be caused by:—
(i) No pressure in the hydraulic system.
(ii) Faulty attachment of hydraulic ram to rear sear release unit.
(iii) Seizure of trigger levers, Bowden cable control valve or gland.
(iv) Excessive slack in the Bowden cables.
(v) Faulty attachment of fire and safe.
Remedy: Make necessary adjustment or repairs.

61. Guns stop firing. This may be caused by:—
(i) Loss of pressure in the hydraulic system.
(ii) Faulty attachment of hydraulic ram to rear sear release unit.
(iii) Fracture or wear of fire and safe unit.
(iv) Broken firing control Bowden cable.
Remedy: Make necessary adjustment or repairs.

62. Runaway gun may be caused by seizure of rear sear release unit push rod or rear sear lever return spring broken.
Remedy: Repair necessary part.

NOTE.—Table of faults and remedies may be found in the appendices to the relevant chapters of A.P.1659A, Volume I, and the appendix of A.P.1641E, Volume I, Part 2, Chapter 1.

https://ww2aircraft.net/

GUN INSTALLATION

63. As a general rule Browning guns are fitted to Frazer Nash turrets. In several nose turrets, however, Vickers G.O. No. 3 Mark I guns are fitted.

64. When fitting Browning guns to Frazer Nash turrets, a trunnion thread protector is fitted to the trunnion block. Care should be taken to ensure that the correct gun attachment pin is fitted, and that the threaded end is facing inwards, so that the lever of the front attachment is not fouled.

65. When adjusting the guns it may be found that when they are correctly harmonized, the rear sear release unit may foul the cam lever of the rear attachment of the gun mounting. This may be due to the fact that a left-handed attachment has been fitted instead of a right-hand attachment or vice-versa.

66. In multi-gun turrets there is affixed a master gun (in relationship to the sight). The other guns are adjustable both vertically and horizontally.

67. The gun sight (reflector, prismatic or gyro) is fitted to a sight bracket mounted on the sight arm; the bracket is dowled and held to the sight arm by a stud and nut. The sight and bracket can be removed without disturbing the harmonization.

68. When fitting the link ducts or chutes to the gun, care should be taken to ensure that they do not foul the cartridge and bullet stops. Link chutes or ducts are to be examined internally for roughness or bulges caused by spot welding. Do not alter the length of the sight arm or linkage. If adjustments are necessary, set the gun and sight arm horizontal by means of a spirit level. Check with a protractor when the guns are elevated and depressed in various positions—permissible error is one-twelfth of a degree.

69. Distorted transparent panels (perspex) will give false line of sight due to refraction effects.

70. Guns should be unloaded before attempts are made to remove them from the turret. *Remember the round in the breech.*

71. When carrying out harmonization, keep checking through the sight and master gun while making adjustments to the other guns for the turret may move or the guns move from their original settings.

NOTES

https://ww2aircraft.net/

PART II

BRISTOL GUN TURRETS

Introduction

1. There are several types of Bristol gun turrets, which differ in arrangement according to the services required of them, but are similar in general principles.

2. In all the Bristol designs the motive power is hydraulic oil pressure taken from the general hydraulic system of the aeroplane, and generated by a pump mounted on the aero-engine.

3. The system incorporates an auxiliary hand pump for emergency operation and for testing the hydraulic services of the aeroplane, when the engine driven pump is not working. This hand pump is usually mounted in the pilot's cockpit and may be used to provide pressure oil for moving the turret during maintenance operations but is not of sufficient power to form a substitute for the engine pump as a source of pressure for normal operations of the turret.

4. The principle of the hydraulic operation is identical in all Bristol turrets. Two pipes are led to the turret from the aeroplane, one being a pressure pipe and the other a return or exhaust oil pipe. These two pipes enter the turret at a lower point whre they are fitted with means to allow for turret rotation.

5. The Bristol turret Mark III as fitted to Blenheim Mark I and IV aircraft. This turret is partly rotating and enables the single Vickers G.O. machine gun Mark I No. 3 to be trained over a wide field of fire centralizing dead astern. Three distinct movements are provided:—

(*a*) The whole turret may be rotated about its vertical axis through an angle of 60° on each side of the fore and aft central line of the aircraft.

(*b*) The gun may be independently rotated about a vertical axis through an angle of 40° both sides of its mean position in the turret, making the total movement of the gun in azimuth 200°.

(*c*) An angular movement of the gun barrel in a vertical plane between the limits of 60° elevation and 32° depression from the horizontal. With this vertical movement the air-gunner's seat also moves up and down to allow for his sighting of the guns.

These movements are effected by three hydraulic rams mounted inside the frame of the turret.

6. The Bristol centre gun turret Mark I and Mark IE as fitted to the Beaufort Mark I aircraft. This turret has the following range of movement:—

(*a*) A vertical angular movement of the single Vickers G.O. gun in the Mark I turret or the two Vickers G.O. guns in the Mark IE turret of between 60° elevation and 40° depression, relative to the horizontal. With this vertical movement the air gunner's seat moves up and down to allo· for his sighting of the gun.

(*b*) A total movement of the turret in azimuth of 180°, i.e., 90° on each side of dead astern.

(*c*) These movements are effected by the elevation and depression ram inside the turret and by the rotation ram outside the turret.

GENERAL DESCRIPTION OF THE COMPONENT PARTS AND THEIR FUNCTIONS

Engine-driven Pump

7. (*a*) This is a three-stage gear pump and consists of three pairs of gears embodied in a single component, the driving pinion of each pair is keyed to the driving shaft; the followers are free to rotate round a single lay shaft.

(*b*) The body of the pump is built up of transverse sections which provide oil-tight housings for the gears and the oil ducts.

(*c*) The internal oilways conduct the oil through three stages, then to the outlet. The pressure is stepped up at each stage.

(*d*) A spring-loaded ball relief valve opens when the oil pressure becomes excessive and by-passes the oil to the inlet side.

(*e*) The body sections and end covers are held together by eight bolts. the end covers house ball or roller bearings for the driving shaft.

(*f*) The shaft is sealed at its projecting end by a "GITS" oil seal held in place by a circlip. The joints between sections and end covers are made by direct contact of the machined surfaces without the use of jointing material.

(*g*) The engine driven gear pump delivers pressure oil to the turret at approx. 600/700 lbs. per sq. inch in the Blenheim aircraft and approx. 800 lbs. per sq. inch in the Beaufort aircraft.

Hydraulic Tank

8. This is fitted in the hydraulic circuit, the filter and filler are so positioned that the tank cannot be overfilled. Its capacity is 2 gallons, but oil content should not exceed 1 gallon. An air vent is fitted in the top of the tank to allow any imprisoned air in the system to escape.

Main Relief Valve

9. (*a*) The main relief valve is a poppet type valve, spring-loaded by two concentric springs and contained in the relief valve housing.

(*b*) A screwed cap and washer compress the springs, so keeping the valve on its seating. Two oilways are drilled through the body and connect with the pressure and exhaust lines.

(*c*) When the oil pressure becomes excessive in the pressure pipe, oil will be by-passed into the exhaust line.

The valve will lift when the pressure oil exceeds—

(i) Approx. 600/700 lbs. per sq. in. in the Blenheim turret.

(ii) Approx. 800 lbs. per sq. inch in the Beaufort turret.

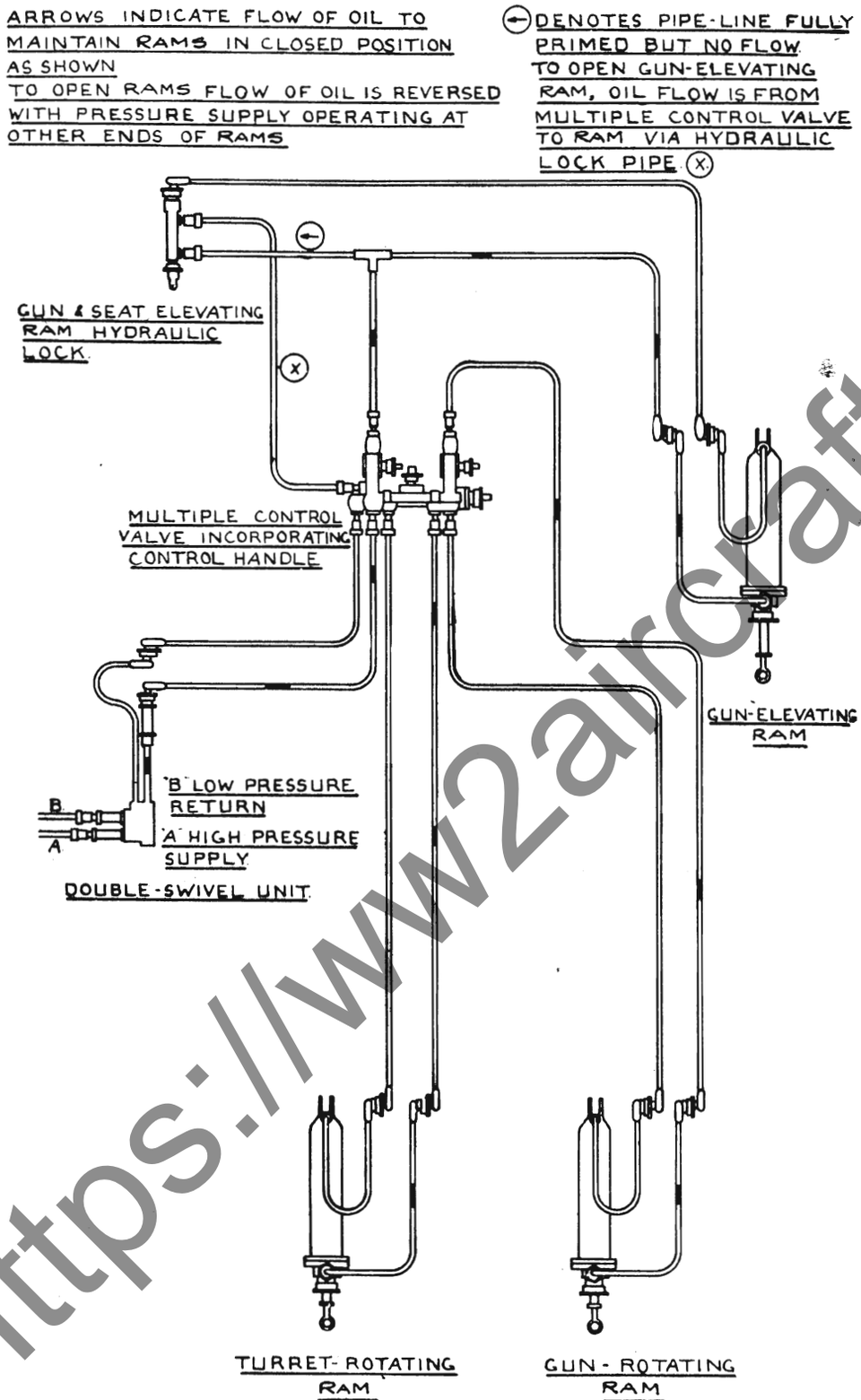
https://ww2aircraft.net/

(*d*) The relief valve is capable of passing the full delivery of the engine driven gear pump. The relief valve will operate—

(i) In the event of a blockage in the system.

(ii) When the master valve is operated and the elevation and rotation valves are centralized.

(iii) When the turret and/or the guns have operated to their limit and the master valve rotation and/or elevation valves still operate.


ARROWS INDICATE FLOW OF OIL TO MAINTAIN RAMS IN CLOSED POSITION AS SHOWN
TO OPEN RAMS FLOW OF OIL IS REVERSED WITH PRESSURE SUPPLY OPERATING AT OTHER ENDS OF RAMS
DENOTES PIPE-LINE FULLY PRIMED BUT NO FLOW TO OPEN GUN-ELEVATING RAM, OIL FLOW IS FROM MULTIPLE CONTROL VALVE TO RAM VIA HYDRAULIC LOCK PIPE (X)
GUN & SEAT ELEVATING RAM HYDRAULIC LOCK
(X)
MULTIPLE CONTROL VALVE INCORPORATING CONTROL HANDLE
GUN-ELEVATING RAM
B
A
'B' LOW PRESSURE RETURN
'A' HIGH PRESSURE SUPPLY
DOUBLE-SWIVEL UNIT
TURRET-ROTATING RAM
GUN-ROTATING RAM

Oil Filter

10. A gauze filter is fitted in the return circuit near the engine pump to prevent foreign particles damaging the hydraulic components.

The Swivel Joint

11. In the Blenheim turret, pressure oil enters and exhaust oil returns from the turret, through a double swivel unit, which consists of two swivel joints mounted in the centre of the main spindle at the base of the turret.

The swivel joint consists of a cup-shaped fitting, surrounded by an outer gland nut attached to one pipe. On the outer pipe is a bearing and collar which when fitted together allow movement of the pipe without restricting the flow of oil. The addition of a gland ring and packing prevent leakage of the oil from the joint.

https://ww2aircraft.net/

Swivel Feed Unit

12. In the Beaufort turret, oil enters and returns from the turret through the swivel feed unit, in which are four oil passages and ports; suitable oil sealing washers are fitted to prevent the oil leakage.

This unit is used only in turrets having a turret rotation ram fitted outside the turret frame, since it then becomes necessary to provide for turret rotation in the oil pipes, which connect the main to the multiple control valve, as well as the pressure and return oil pipe.

The Multiple Control Valve

13. (*a*) The function of the multiple control valve is to group all the hydraulic control valves of the turret into a single unit mounted at a convenient point for their operation. The multiple control valve embodies:—

(i) The master valve.

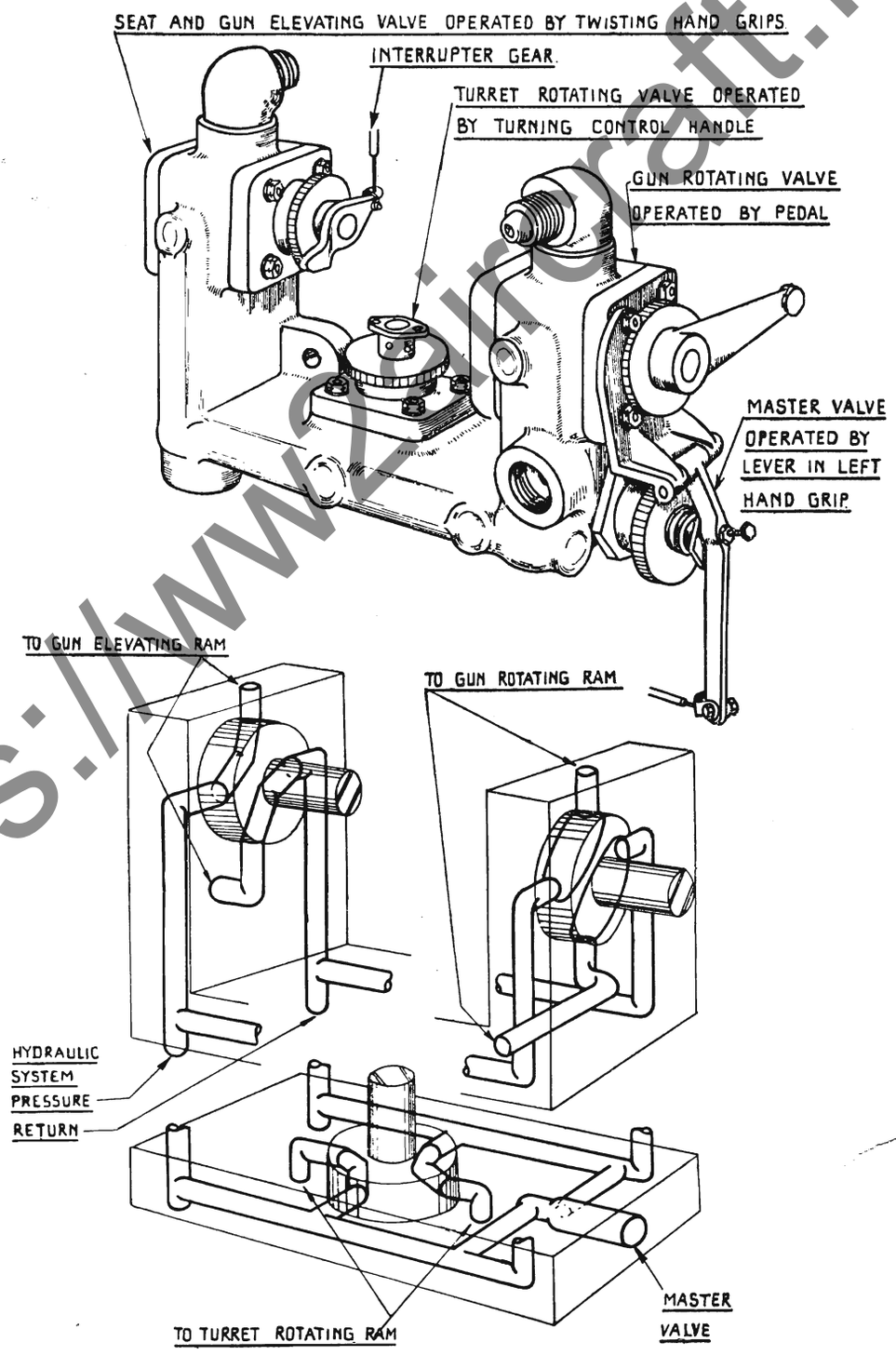
(ii) The turret rotation valve.

(iii) The gun elevating valve.

(iv) On Blenheim turrets the secondary rotation of the guns make it necessary to introduce a fourth valve to the group.

(*b*) The body of the unit consists of a U-shaped casting. The control valves are housed in its base and in each of the vertical arms.

(*c*) In the Mark III turret as fitted to Blenheim aircraft, the master valve is a balanced poppet type single ported valve, normally kept open by a light external spring.


SEAT AND GUN ELEVATING VALVE OPERATED BY TWISTING HAND GRIPS
INTERRUPTER GEAR.
TURRET ROTATING VALVE OPERATED BY TURNING CONTROL HANDLE
GUN ROTATING VALVE OPERATED BY PEDAL
MASTER VALVE OPERATED BY LEVER IN LEFT HAND GRIP
TO GUN ELEVATING RAM
TO GUN ROTATING RAM
HYDRAULIC SYSTEM PRESSURE
RETURN
TO TURRET ROTATING RAM
MASTER VALVE

https://www.2aircraft.net/

(*d*) The turret rotation valve, gun elevating valve and the gun rotating valve are rotary plug type, double ported reversing valves.

(*e*) The master valve is operated through a Bowden cable, by a lever in the left grip of the control handles.

(*f*) The turret rotation valve is operated through a linkage by turning the hand grips on the control handles about their vertical axis in the corresponding direction that the turret is required to be rotated.

(*g*) The gun elevating valve is operated through a linkage by twisting the hand grips about their horizontal axis, forward for depression, backward for elevation.

(*h*) The gun rotation valve is operated by foot pedals; depression of the right foot pedal operates the valve so that the gun will rotate to the right, and vice versa.

(*i*) The air gunner's foot pedals incorporates a spring-loaded plunger lock, which engages with one of the five holes in a quadrant fixed to the gun tube. The plunger is withdrawn from engagement with the quadrant, as either pedal is depressed. The gun tube is thus released to take up any other of the provided positions, where it is automatically locked on return of the pedal lever to the horizontal position.

(*j*) In the Mark I and Mark IE centre gun turrets as fitted to the Beaufort aircraft, the master valve is a non-reversing single-ported plug type rotary valve, normally kept open by an external spring.

(*k*) The turret rotation valve and the gun elevation valve are both double-ported rotary type reversing valves.

(*l*) The master valve is operated by a Bowden cable and lever in the left-hand grip of the control handles. The rotation and elevation valves are operated by turning or twisting the control handle in the required direction.

The slot in the rotation valve is approximately ·016 in. wide and that in the elevation valve is approximately ·014 in. wide. The difference is incorporated so that the rotation will get slightly more oil flow owing to the heavier nature of its work. On the end of all valve body shafts there is a cut denoted the number of ports and the position of same. These cuts are used for the primary setting of the valves which is approximately horizontal.

Functioning of the Valve Bores and Valves

14. (*a*) The master valve held open by its spring permits the pressure oil to flow direct to the return line without doing any work.

(*b*) As soon as the master valve is closed, the pressure oil flows to the elevating and rotating control valves. Should these valves be closed the pressure in the system is relieved by the main relief valve of the hydraulic system.

(*c*) Immediately a control valve or valves are opened the relief valve closes automatically, so that the by-passing ceases and the oil pressure operates the turret and/or the gun or guns.

The Hydraulic Rams

15. (*a*) The elevation and rotation rams are double acting, their cylinders having pistons fitted with two cup-shaped rings of synthetic rubber and fabric, disposed back to back.

(*b*) The cylinder body has a closed end which incorporates a bearing for the fulcrum pin about which the ram oscillates. The other end is closed by a cover having suitable oil sealing rings and a gland for the piston rod. Oil pipe connections are fitted at both ends and each ram is hydraulically coupled to its operating valve, so that as pressure is introduced into one end, the other is connected to the return pipe.

(*c*) The piston rods are adjustable for length by means of end fittings, having a screwed shank and lock nut.

The Turret Assembly

16. (*a*) The turret structure rotates on rollers, which form the upper anchorage. These rollers retain the turret mounting ring both laterally and vertically while permitting free rotational motion. The base of the turret rotates round a central main spindle which forms the lower anchorage.

(*b*) The drive for this rotational movement is provided (in the Mark III turret on Blenheim A/C) by the rotation ram which is mounted on a bracket in the turret and reacts on a pin fixed to the floor of the aeroplane. In the Mark I and Mark IE turret as fitted to the Beaufort aircraft, the turret is rotated by the rotation ram, which is fixed to the floor of the aeroplane outside the turret frame. A drum is attached to the base of the turret, a single and double cable is wound round three grooves in the drum and attached to a driving link connected to the hydraulic ram. The motion of the ram piston rod causes the drum and turret to rotate.

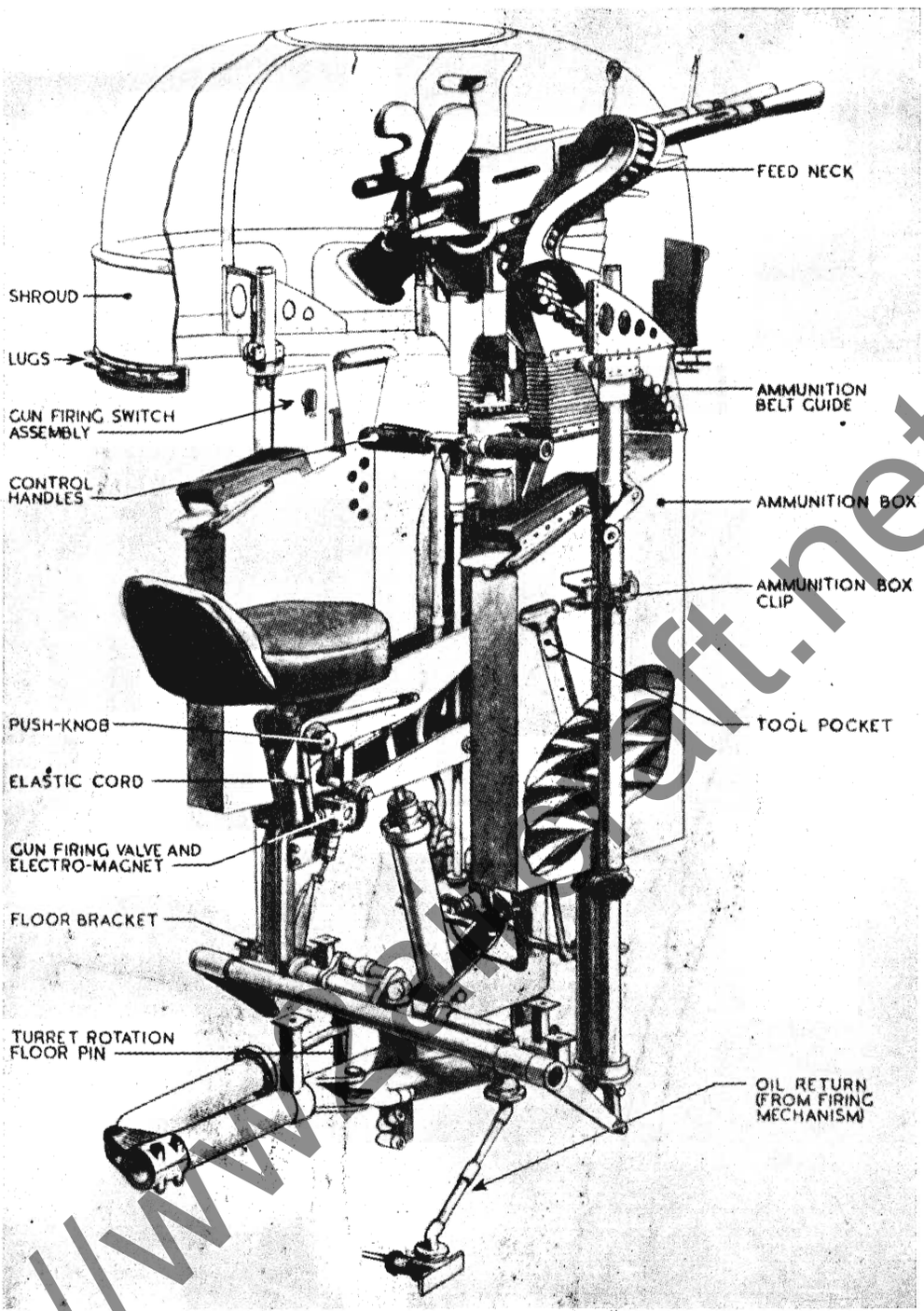
(*c*) The cupola and wind excluder of the Blenheim turret is retractable, so that when the turret is not in use the cupola can be lowered into the body of the aeroplane, thus reducing wind resistance and increasing the aeroplane's speed. The cupola of the Beaufort turret is not retractable.

(*d*) The gun or guns are mounted on a chassis or cradle supported at one end by a fixed hinge, the other end is connected to one end of a fulcrum lever, which is pivoted centrally to the main pillar. On the other end of the fulcrum lever is the air gunner's seat. Fitted below the air gunner's seat is the elevating ram, which moves the air gunner's seat up and down. This vertical motion is imparted to the gun cradle and gun or guns.

(*e*) Seat adjustment is provided in the turrets to allow for variation in the height of the different air gunners; also a safety belt of approved type is fixed to the seat.

(*f*) The oxygen supply, intercommunication socket, etc., are fitted to the side of the aeroplane within easy reach of the air gunner.

http://ww2aircraft.net/



The Hydraulic Lock

17. (*a*) A hydraulic lock is fitted in the pipe line between the elevation control valve and the left end of the gun and seat elevating ram. This is a valve which automatically keeps the seat at any height to which it has been raised, by preventing creep leakage of the control valves.

(*b*) A hand control is provided whereby the air gunner can lower his seat in the event of a failure in the hydraulic system, also for lowering the seat while servicing the turret, or for removing a casualty air gunner.

(*c*) This unit consists of a cylindrical chamber having a small floating piston. Two pipe unions are provided at the side of the chamber, so that pressure oil may be introduced on either side of the piston.

(*d*) The cylinder is divided unequally and transversely near one of these unions, the shorter part is screwed into the other. A gasket ensures an oil-tight joint. The free end of the longer part is closed either by a screwed-in plug with a union for another oil pipe connection, or with a swivel joint which permits the connecting pipe to rotate in a gland.

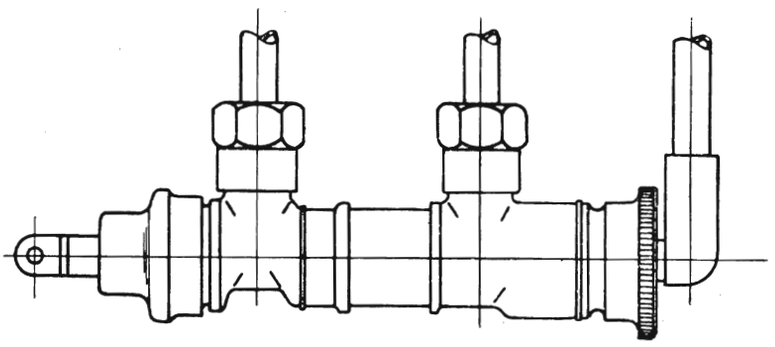
(*e*) The oil which passes through this pipe is not always in direct communication with that in the cylinder, as a spring-loaded, cone-seated poppet valve is interposed, which may cut off the flow of oil to the cylinder from the pipe under consideration.

(*f*) The stem of the poppet valve is supported in the floating piston, which has a central hole forming a valve guide. This hole is of such a depth that the piston moving has a limited free travel, eventually picking up the valve stem and lifting the valve off its seat.

(*g*) The shorter part of the cylinder is closed at its face end by a gland cover through which may be moved longitudinally inwards against the action of a spring housed in the gland cover. This rod terminates externally to a hand lever, to which it may be fitted. The internal end of the rod is provided with an adjusting screw and lock-nut.

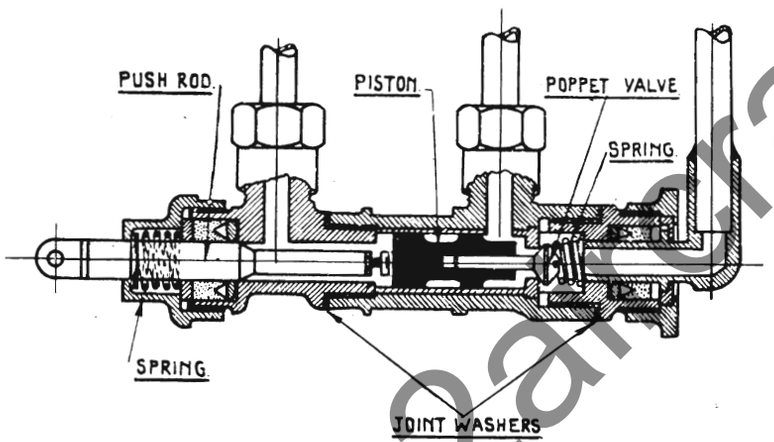
https://www.raf.net/

(*h*) When the rod is pressed inwards this screw comes against the piston which moves into engagement with the poppet valve stem, lifting the valve from its seat.



EXTERNAL VIEW

HYDRAULIC LOCK



SECTIONAL VIEW

Operation

18. (*a*) The operation of the unit can be seen in the illustration which shows how the lock is coupled up in the elevating ram hydraulic circuit. The pipes carrying pressure (i.e., supply) oil are marked with chain dotted lines.

(*b*) While the ram is lifting the seat the poppet valve acts as a spring-loaded non-return valve permitting the passage of pressure oil to the lower part of the ram, but closing automatically as soon as the pressure supply is cut off, thus preventing the seat from descending under the air gunner's weight.

(*c*) When the control valve is set to lower the seat the pressure supply oil is introduced to the left-hand end of the lock cylinder thereby causing the floating piston to move to the right against the relatively low pressure of the return oil. The piston is thus forced against the stem of the valve, causing it to lift off its seating. As the seat descends under the pressure introduced above the piston of the ram, the oil from the lower part of the ram is thus permitted to pass the poppet valve to the return pipe line.

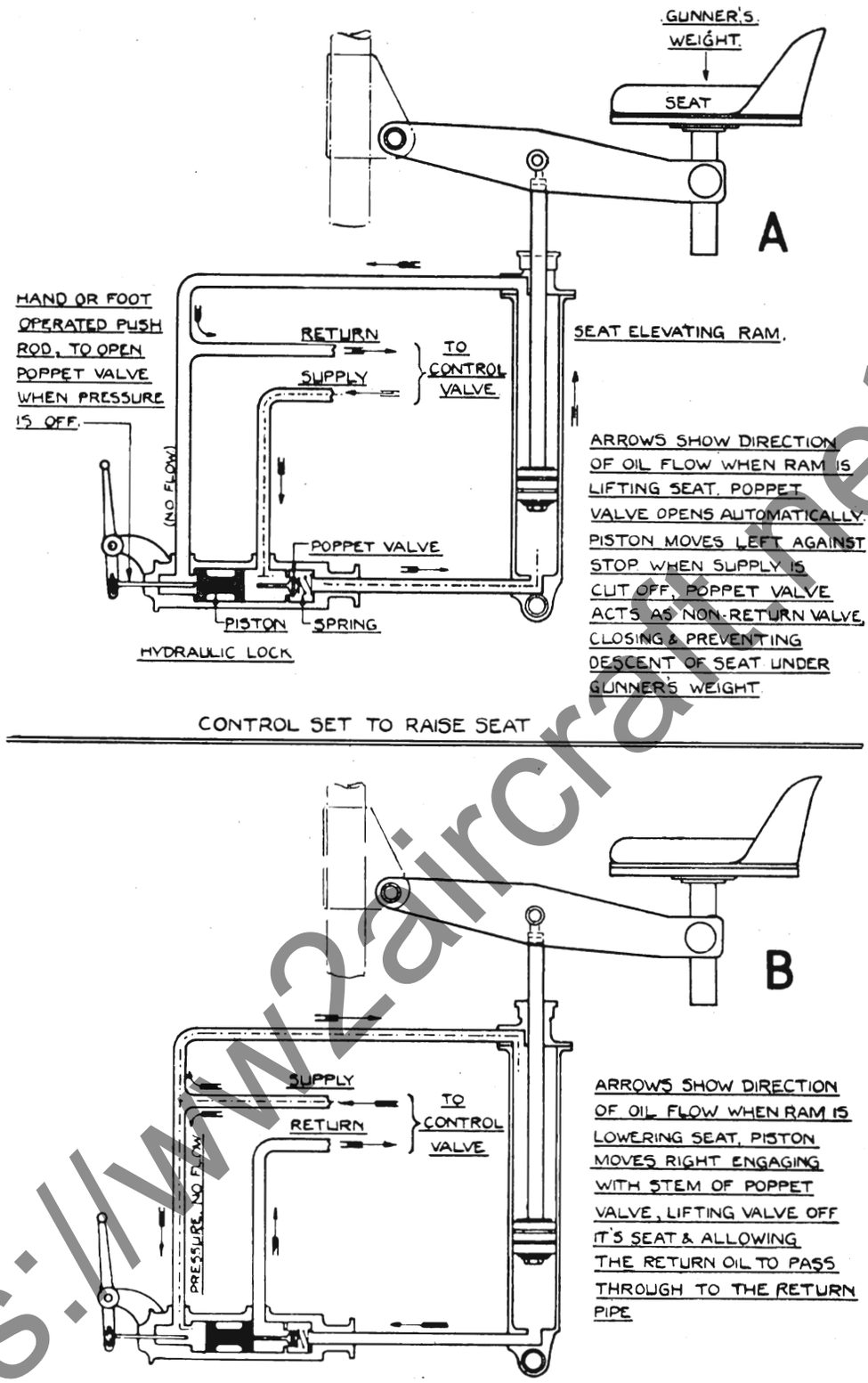
(*d*) It will be seen from the diagram that the valve may also be opened by the hand control whereby the piston is forced to the right by means of a push rod. This control is for use when the supply is off and it is necessary to lower the seat.

The Interrupter Gear (Blenheim Turret)

19. (*a*) On the Blenheim turret this device is a mechanical arrangement which comes into operation as the gun is being depressed and is to avoid damage either to the turret mechanism or aeroplane, which might arise if the gun were forced downwards against the fuselage fairing, the shape of which near the turret restricts the downward angle of the gun as the direction of fire moves aft.

(*b*) A shaped lever is mounted on the forward end of the gun chassis, having a projection which extends below the barrel of the gun. Normally, it is held away from the gun, but it is fitted in such a position as to engage with the interrupter gear ram when the gun is brought down against it. When this occurs the lever is forced upwards against the barrel of the gun, its motion being transmitted through a Bowden cable to operate directly on the elevating scale lever. The tension return spring is anchored to the elevating control rod upon which it maintains an upward axial pull.

https://www.2aircraft.net/


GUNNER'S WEIGHT
SEAT
A
HAND OR FOOT OPERATED PUSH ROD, TO OPEN POPPET VALVE WHEN PRESSURE IS OFF.
RETURN
SUPPLY
TO CONTROL VALVE
SEAT ELEVATING RAM.
(NO FLOW)
POPPET VALVE
PISTON
SPRING
HYDRAULIC LOCK
ARROWS SHOW DIRECTION OF OIL FLOW WHEN RAM IS LIFTING SEAT. POPPET VALVE OPENS AUTOMATICALLY. PISTON MOVES LEFT AGAINST STOP WHEN SUPPLY IS CUT OFF, POPPET VALVE ACTS AS NON-RETURN VALVE, CLOSING & PREVENTING DESCENT OF SEAT UNDER GUNNER'S WEIGHT.
CONTROL SET TO RAISE SEAT
B
SUPPLY
RETURN
TO CONTROL VALVE
PRESSURE (NO FLOW)
ARROWS SHOW DIRECTION OF OIL FLOW WHEN RAM IS LOWERING SEAT. PISTON MOVES RIGHT ENGAGING WITH STEM OF POPPET VALVE, LIFTING VALVE OFF IT'S SEAT & ALLOWING THE RETURN OIL TO PASS THROUGH TO THE RETURN PIPE
CONTROL SET TO LOWER SEAT

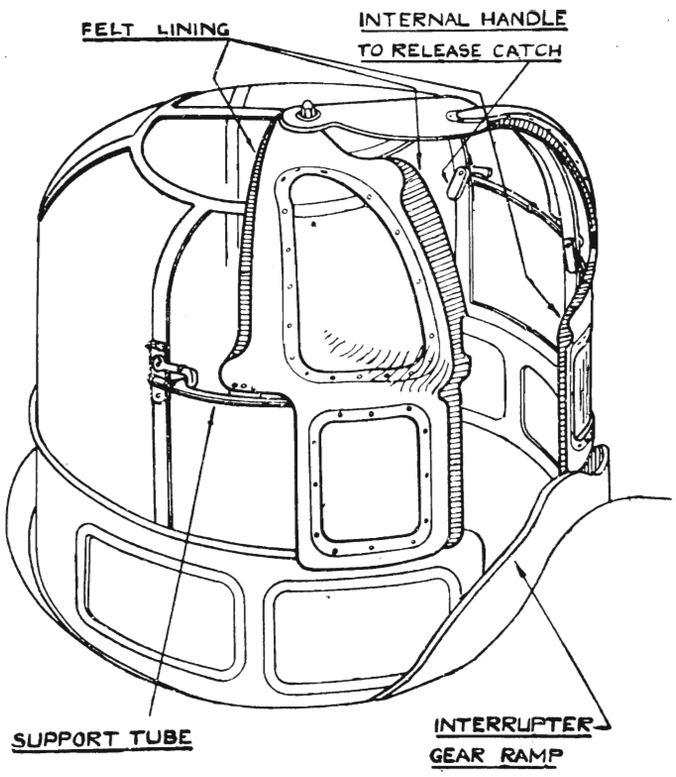
(*c*) The elevating control rod is designed to render the functioning of the interrupter gear independent of the force applied to the control handles. The upper portion of the rod is so constructed that it may extend telescopically against the compression of an internal spring sufficiently stiff to maintain the rod at its normal length while the elevating control is being operated. The internal spring is brought into play when the interrupter gear is in action and then only if the control handles are persistently held in the gun depressed position.

(*d*) The interrupter gear ramp shape corresponds to the projecting portions of the aeroplane, i.e., the tail planes, fin and rudder; thus the interrupter gear prevents the gun from being depressed into these areas where the field of fire would damage the aeroplane structure. It also prevents the gun barrel from fouling the fuselage.

(*e*) The gun is fired by a trigger lever and Bowden cable operating a remote control mechanical sear release.

(*f*) The interrupter gear does not stop the gun firing, but prevents the field of fire damaging projecting areas of the aeroplane.

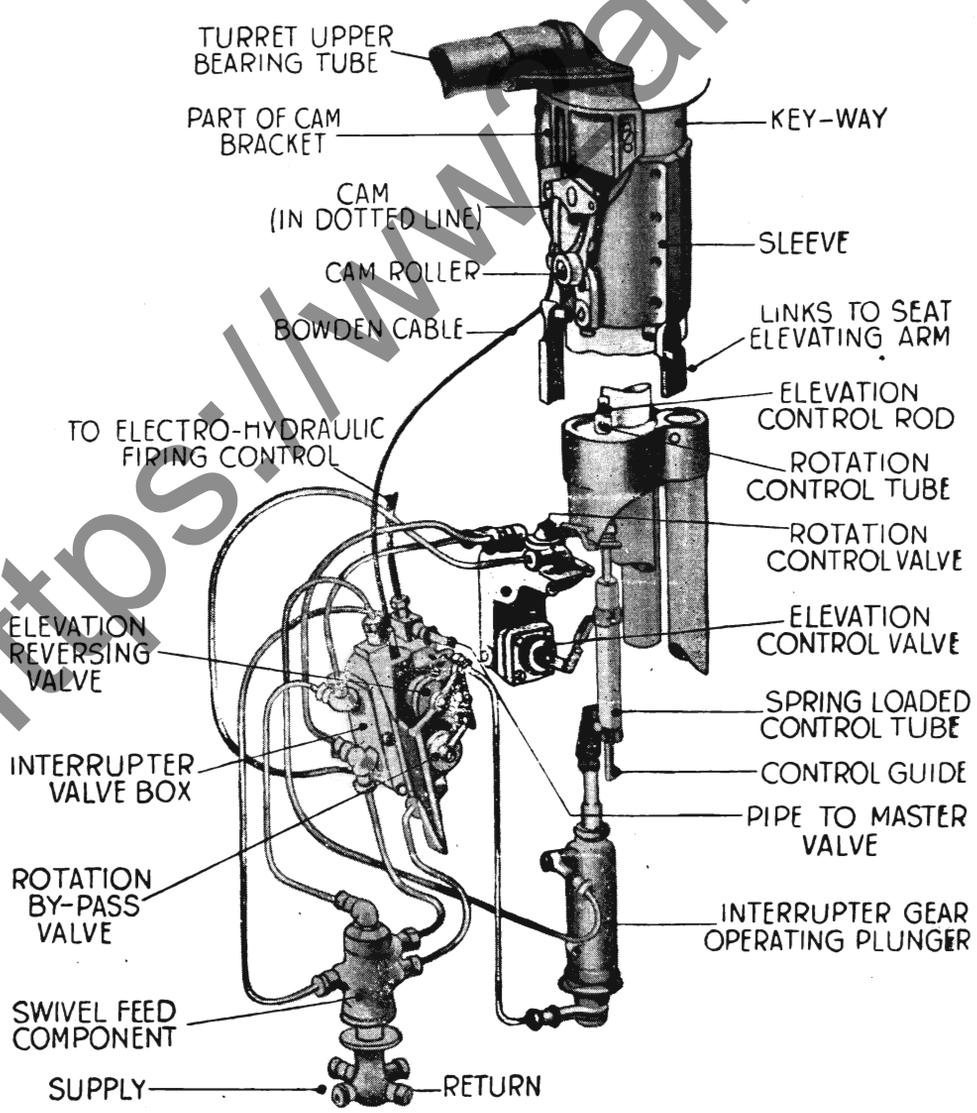
https://ww2aircraft.net/



The Interrupter Gear (Beaufort Turret)

20. (*a*) The earlier type of Beaufort turrets are fitted with an interrupter gear but the gun is fired manually, i.e., a Bowden control mechanism connected at one end to a gun firing trigger on the right-hand grip of the control handles, the other end is connected to a firing lever which together with a Bowden stop, is mounted on the gun.

(*b*) The later type of Beaufort turrets are fitted with a similar interrupter gear, but the gun or guns are fired by an electro-hydraulic firing mechanism and firing interrupter.



https://www.aircraft.net/

Description of the Interrupter Gear

21. (*a*) This gear prevents damage due to contact with the aeroplane fairing when the gun is being depressed or when the turret is rotated while the gun is depressd. A cam similar in shape to the contour of the fairing behind the turret, but inverted, is fixed to the top bearing bracket.

(*b*) A sleeve rotating with the turret and linked to the seat elevating arm carries a roller which makes contact with the cam when the interrupter gear comes into use. The roller is carried on links which operate a Bowden control when the roller is driven against the cam.

(*c*) The Bowden control actuates the interrupter valve box, which contains two hydraulic plug valves coupled together. The upper valve controls an operating plunger fixed vertically below the elevation control rod and connected to it by a slotted link.

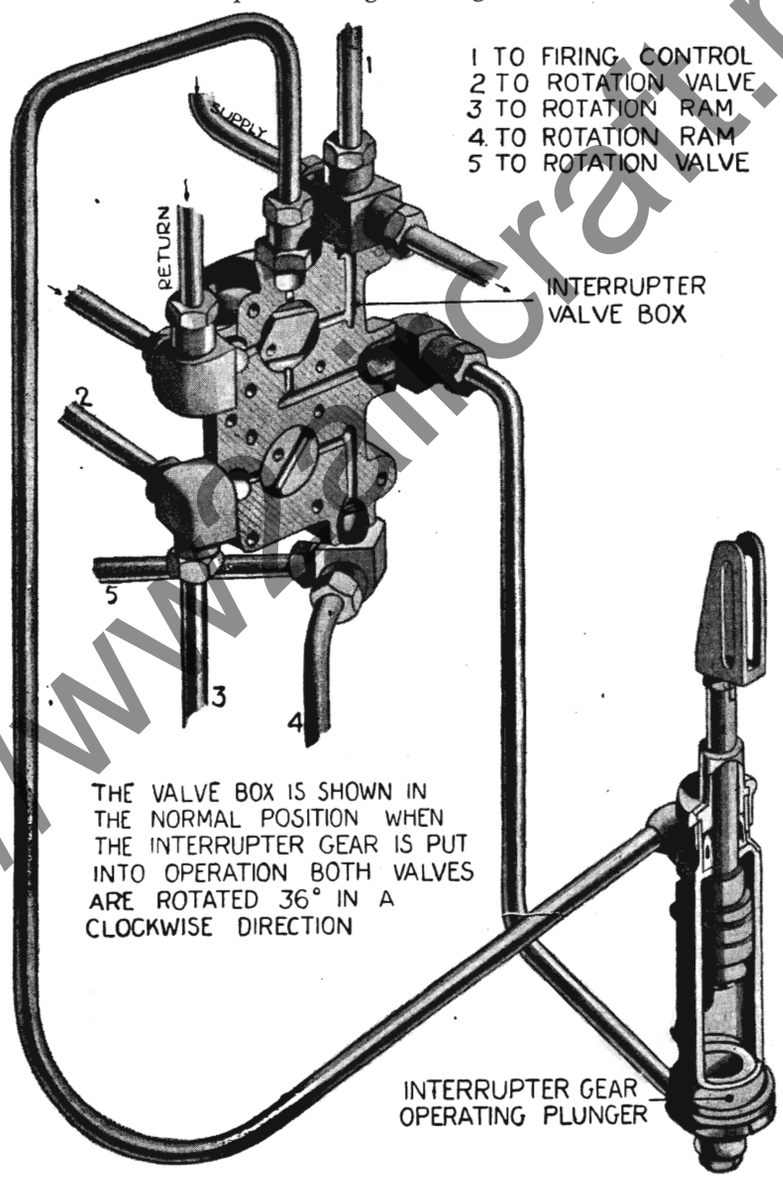
(*d*) The elevation control rod has, at its lower end, a spring-loaded control tube to which is attached the linkage of the elevation control valve and the connection for the interrupter gear operating plunger.

(*e*) When the interrupter gear is not in action, the control handles can be moved to elevate or depress the gun; the control rod and the spring-loaded control tube move as a unit.

(*f*) When the gun is depressed and the interrupter gear comes into action, the spring-loaded control tube is pulled down against its internal compression spring and moves the elevation control valve, independently of movement of the control handles, to the full elevation position of the gun.

(*g*) The lower valve, operating at the same time, by-passing the supply of oil to the turret rotation valve, checks the rotation of the turret.

(*h*) This gear does not interrupt the firing of the gun.


1 TO FIRING CONTROL
2 TO ROTATION VALVE
3 TO ROTATION RAM
4 TO ROTATION RAM
5 TO ROTATION VALVE
SUPPLY
RETURN
INTERRUPTER VALVE BOX
THE VALVE BOX IS SHOWN IN THE NORMAL POSITION WHEN THE INTERRUPTER GEAR IS PUT INTO OPERATION BOTH VALVES ARE ROTATED 36° IN A CLOCKWISE DIRECTION
INTERRUPTER GEAR OPERATING PLUNGER

The Electro-Hydraulic Gun Firing Mechanism and Gun Firing Interrupter

22 (*a*) This mechanism is fitted to the later type of Beaufort turrets and works in conjunction with the interrupter gear (which is explained in para. 19).

(*b*) The electro-hydraulic gun firing mechanism is operated by the same trigger and Bowden control used for direct manual operation.

(*c*) The firing control mechanism is mounted on the fulcrum bracket of the turret. The firing interrupter is operated by the sliding interrupter sleeve on the main pillar, and in conjunction with a fixed cam, suspends the firing of the gun when the aeroplane tail surfaces are in the line of fire.

(*d*) The mechanism is operated by hydraulic oil pressure from the main hydraulic system of the aeroplane, and the electric current for actuating the firing control is taken from the storage batteries carried in the aeroplane.

https://www.raf.net/

(*e*) Either one or two guns, depending on the installation, may be fired by the air gunner's ıg trigger on the right-hand of the turret control handles. In addition to the air gunner's trigger th mechanism consists of the following components:—

(i) A firing switch which is lever operated by a Bowden control from the air gunner's firing trigger.

(ii) A firing interrupter switch which is in series with the firing switch. The former is normally closed and constitutes the make-and-break in the firing interrupter.

(iii) An electro-magnet, in series with the firing switch, which operates a hydraulic gun firing valve. This valve supplies hydraulic pressure to the sear release unit on the gun.

(iv) A hydraulic accumulator, provided as a pressure reservoir in the event of a temporary failure of the normal hydraulic supply. This component is connected in the main supply pipe to the gun firing valve.

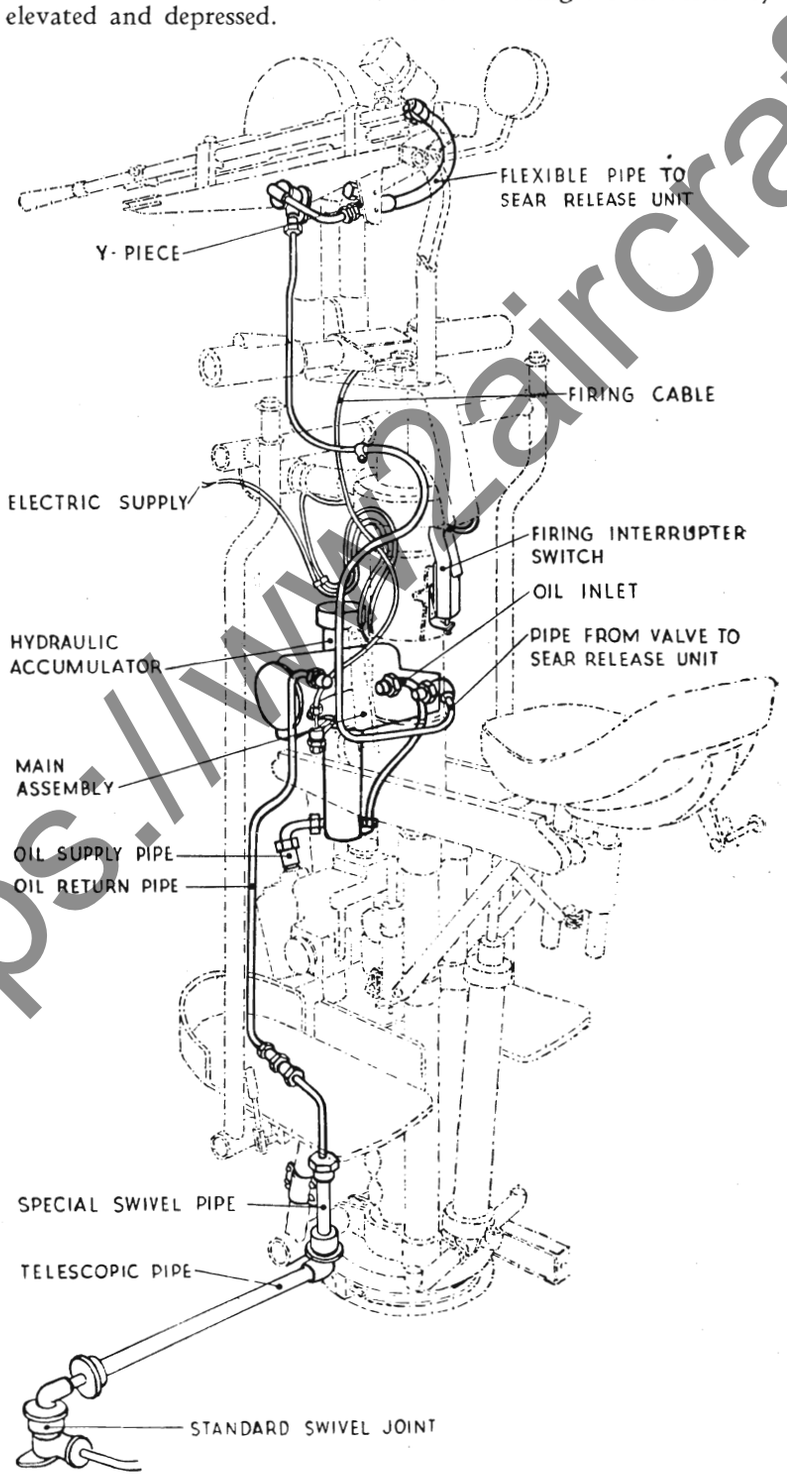
(v) A condenser and two terminal boxes forming part of the electrical equipment.

(vi) A change-over mechanism which may be operated by the air gunner in the event of failure of the electric supply. This mechanism provides for direct mechanical operation of the hydraulic gun firing valve when the air gunner's firing trigger is pressed. Its use precludes, of course, the action of the firing interrupter.

(*f*) With the excepton of the firing interrupter, the foregoing components are grouped in a main assembly mounted on a bracket on the turret frame.

(*g*) The firing interrupter is arranged as follows:—

(i) A surface cam, shaped to conform with the outline of the aeroplane tail surfaces, is fitted to a slider in the turret mechanism, the slider being driven vertically up and down as the gun is elevated and depressed.



https://www.aircraft.net/

(ii) The firing interrupter switch is fixed to the turret frame and is operated by the surface cam when the slider, to which the cam is fixed, moves to an appropriate position. In this way the electrical firing circuit is broken when the line of fire crosses the tail surfaces.

(*h*) A length of duplex cable connects the terminal boxes on the main assembly to a fixed supply socket on the turret frame.

Operation

23. (*a*) When the air gunner's trigger is operated, its motion is transmitted through the Bowden control to the firing switch on the main assembly. The firing switch opens or closes the electric circuit through the electro-magnet which operates the hydraulic gun firing valve, except when the firing interrupter is brought into use.

(*b*) When the firing interrupter switch is operated by contact with the surface cam, the electric circuit through the electro-magnet is broken and the gun firing valve returns to, or remains in, its normal position where it is held by a spring.

(*c*) The operation of the gun firing valve admits oil under pressure to the small pipe which connects with the sear release unit mounted on the gun. Interposed in this pipe is a Y-piece which enables two guns to be fired, each having a separate sear release unit fed from the Y-piece.

(*d*) The oil return pipe at the base of the turret has a system of swivel joints, and a telescopic pipe to allow for turret rotation. The return pipe is connected to the main hydraulic return pipe of the aeroplane.

(*e*) The action of the mechanism is automatic except for the change-over mechanism, which is operated by hand should the electric current fail.

Description of Components

24. (*a*) The firing switch is a standard push-button switch and is operated by a lever connected to the Bowden firing control from the air gunner's firing lever.

(*b*) The electro-magnet is made from parts of a 24-volt rotax magnetic relay, enclosed in a special casing to facilitate its use with a hydraulic gun firing valve. The casing has a short cylinder at one end to accommodate the electro-magnet, a concial middle part, and at the opposite end a screwed sleeve with lock-nut to connect it to the hydraulic gun firing valve, the sleeve being held in position in the casing by a set-screw. The electro-magnet consists of an iron shroud with a central hollow core. A coil fills the annular space between the core and shroud, the ends of the coil being connected to hooded terminals on an external terminal block.

(*c*) The armature is a soft iron disc, equal in external diameter to the shroud, and is mounted on a central rod. The armature is prevented from making contact with the shroud and central core by a phosphor-bronze disc. The central rod passes through the core and sleeve and projects into the gun firing valve where it engages a plunger. The cylindrical end of the casing is closed by a screwed cover with a locking wire.

Gun Firing Valve

25. (*a*) The gun firing valve consists of a body in which is formed an oil chamber at right angles to an orifice which accommodates a piston valve plunger and cylinder. A screwed spigot is formed on the body for the attachment of the electro-magnet, the central rod of which projects into the spigot and butts against the piston valve plunger. The body is drilled and threaded for the oil inlet, outlet, and return unions. The oil inlet and oil outlet connect with the oil chamber, the former being normally closed by a spring-loaded ball valve, while the latter is permanently open. The oil return breaks through opposite a ring of ports in the piston valve cylinder.

(*b*) Two holes, which are used to facilitate manufacturing the body and assembling the components, are closed by screw plugs.

(*c*) The piston valve plunger is a cylindrical trunk piston having an extension of reduced diameter at each end. It is moved axially in the cylinder by the central rod of the electro-magnet, which engages one of the reduced ends when the magnet is energized, and is returned to its normal position by a spring. The other end of the piston valve plunger projects through a sleeve in the body and has a knurled adjustment disc for hand adjustment of the change-over mechanism. The piston valve plunger return spring is accommodated in the sleeve.

(*d*) The piston valve cylinder has a ring of ports which connect with a slot in the body opposite the oil return. The middle of the piston valve plunger is slightly reduced in diameter so that in the normal position of the valve there is a free oil passage between the oil chamber and the oil return pipe.

(*e*) The ball valve is seated in a cup which is pressed into the oil inlet. The valve spring is held in place by the inlet union which is screwed into the body with a gasket joint. The valve is opened by a lever which pivots on a pin in the oil chamber. A screw, having a lock-nut, passes through the lever and the seating, the joint on the screw resing on the ball. The free end of the lever passes through holes in the cylinder and liner resting on a hole in the middle of the piston valve plunger. When the piston valve plunger is moved by the electro-magnet the lever lifts the valve off its seat and opens the oil inlet.

(*f*) The oil inlet, outlet, and return unions are connected to the hydraulic accumulator, sear release unit, and oil return pipe respectively.

(*g*) The oil chamber is normally open to the sear release unit and the oil return pipe, the inlet from the hydraulic accumulator being closed by the ball valve. When the firing switch is pressed the electro-magnet is energized and the armature, moving inwards, pushes the piston valve

https://www.2ndcraft.net/

(ii) The firing interrupter switch is fixed to the turret frame and is operated by the surface cam when the slider, to which the cam is fixed, moves to an appropriate position. In this way the electrical firing circuit is broken when the line of fire crosses the tail surfaces.

(*h*) A length of duplex cable connects the terminal boxes on the main assembly to a fixed supply socket on the turret frame.

Operation

23. (*a*) When the air gunner's trigger is operated, its motion is transmitted through the Bowden control to the firing switch on the main assembly. The firing switch opens or closes the electric circuit through the electro-magnet which operates the hydraulic gun firing valve, except when the firing interrupter is brought into use.

(*b*) When the firing interrupter switch is operated by contact with the surface cam, the electric circuit through the electro-magnet is broken and the gun firing valve returns to, or remains in, its normal position where it is held by a spring.

(*c*) The operation of the gun firing valve admits oil under pressure to the small pipe which connects with the sear release unit mounted on the gun. Interposed in this pipe is a Y-piece which enables two guns to be fired, each having a separate sear release unit fed from the Y-piece.

(*d*) The oil return pipe at the base of the turret has a system of swivel joints, and a telescopic pipe to allow for turret rotation. The return pipe is connected to the main hydraulic return pipe of the aeroplane.

(*e*) The action of the mechanism is automatic except for the change-over mechanism, which is operated by hand should the electric current fail.

Description of Components

24. (*a*) The firing switch is a standard push-button switch and is operated by a lever connected to the Bowden firing control from the air gunner's firing lever.

(*b*) The electro-magnet is made from parts of a 24-volt rotax magnetic relay, enclosed in a special casing to facilitate its use with a hydraulic gun firing valve. The casing has a short cylinder at one end to accommodate the electro-magnet, a concial middle part, and at the opposite end a screwed sleeve with lock-nut to connect it to the hydraulic gun firing valve, the sleeve being held in position in the casing by a set-screw. The electro-magnet consists of an iron shroud with a central hollow core. A coil fills the annular space between the core and shroud, the ends of the coil being connected to hooded terminals on an external terminal block.

(*c*) The armature is a soft iron disc, equal in external diameter to the shroud, and is mounted on a central rod. The armature is prevented from making contact with the shroud and central core by a phosphor-bronze disc. The central rod passes through the core and sleeve and projects into the gun firing valve where it engages a plunger. The cylindrical end of the casing is closed by a screwed cover with a locking wire.

Gun Firing Valve

25. (*a*) The gun firing valve consists of a body in which is formed an oil chamber at right angles to an orifice which accommodates a piston valve plunger and cylinder. A screwed spigot is formed on the body for the attachment of the electro-magnet, the central rod of which projects into the spigot and butts against the piston valve plunger. The body is drilled and threaded for the oil inlet, outlet, and return unions. The oil inlet and oil outlet connect with the oil chamber, the former being normally closed by a spring-loaded ball valve, while the latter is permanently open. The oil return breaks through opposite a ring of ports in the piston valve cylinder.

(*b*) Two holes, which are used to facilitate manufacturing the body and assembling the components, are closed by screw plugs.

(*c*) The piston valve plunger is a cylindrical trunk piston having an extension of reduced diameter at each end. It is moved axially in the cylinder by the central rod of the electro-magnet, which engages one of the reduced ends when the magnet is energized, and is returned to its normal position by a spring. The other end of the piston valve plunger projects through a sleeve in the body and has a knurled adjustment disc for hand adjustment of the change-over mechanism. The piston valve plunger return spring is accommodated in the sleeve.

(*d*) The piston valve cylinder has a ring of ports which connect with a slot in the body opposite the oil return. The middle of the piston valve plunger is slightly reduced in diameter so that in the normal position of the valve there is a free oil passage between the oil chamber and the oil return pipe.

(*e*) The ball valve is seated in a cup which is pressed into the oil inlet. The valve spring is held in place by the inlet union which is screwed into the body with a gasket joint. The valve is opened by a lever which pivots on a pin in the oil chamber. A screw, having a lock-nut, passes through the lever and the seating, the joint on the screw resing on the ball. The free end of the lever passes through holes in the cylinder and liner resting on a hole in the middle of the piston valve plunger. When the piston valve plunger is moved by the electro-magnet the lever lifts the valve off its seat and opens the oil inlet.

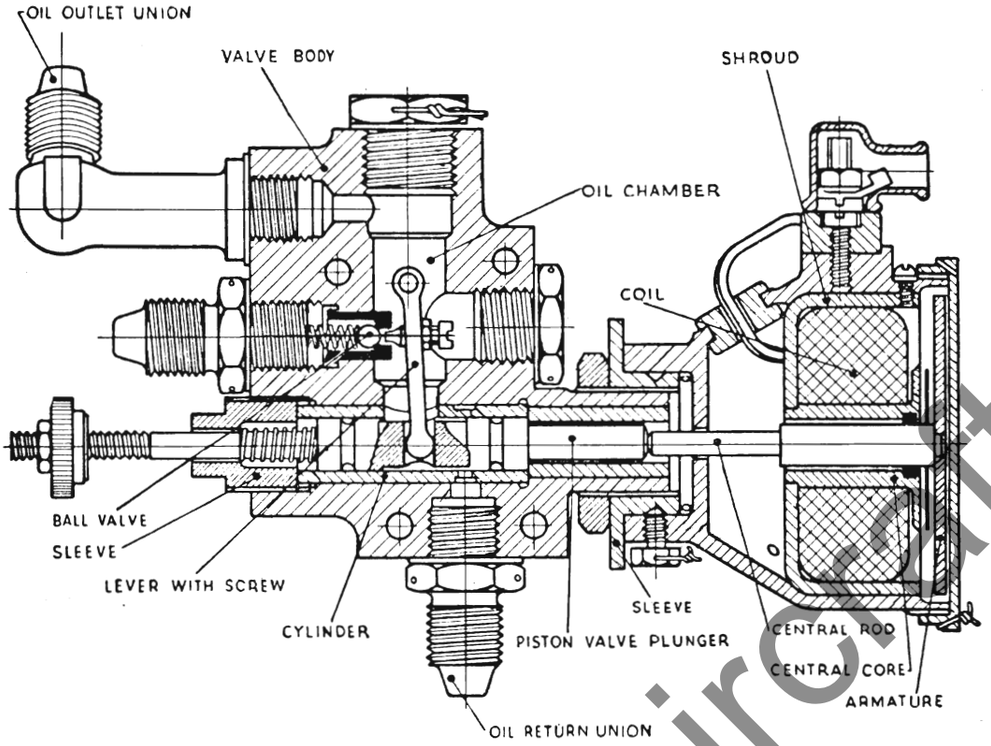
(*f*) The oil inlet, outlet, and return unions are connected to the hydraulic accumulator, sear release unit, and oil return pipe respectively.

(*g*) The oil chamber is normally open to the sear release unit and the oil return pipe, the inlet from the hydraulic accumulator being closed by the ball valve. When the firing switch is pressed the electro-magnet is energized and the armature, moving inwards, pushes the piston valve

https://ww2aircraft.net/

plunger into position to close the ports in the cylinder liner and blank-off the passage to the oil return. At the same time, the piston valve plunger causes the lever to pivot on its pin and open the ball valve, thus admitting oil under pressure from the hydraulic accumulator to the oil chamber and to the sear release unit through the oil outlet union.

(*h*) When the firing switch is released, the spring returns the piston valve plunger, and the lever, returning to its normal position, allows the ball valve to close. At the same time the ports in the cylinder are opened and the oil chamber connected to the oil return pipe.



Gun firing valve and electro-magnet, sectional view

Hydraulic Accumulator

26. This is connected to the oil pipe leading from the top of the interrupter valve box to the gun firing valve of the electro-hydraulic firing mechanism. It consists of a cylinder containing a piston which is forced upwards by oil pressure so as to compress air pocketed above it to provide a reserve pressure which would enable the gun to be fired several times if the main hydraulic supply should fail.

Firing Interrupter Switch and Operating Mechanism

27. (*a*) The firing interrupter switch is a Burgess micro-switch Mark I of single-throw type and is mounted in a bracket on the main pillar of the turret. It is a sensitive component enclosed in a sealed dustproof moulded plastic body, and is connected in series with the firing switch and electro-magnet. A leaf spring operating tongue projects from the body and engages a lever on the switch mounting bracket. The holes in the mounting bracket plates, through which the eccentric switch securing bolt passes, are slotted to enable the interrupter switch to be adjusted.

(*b*) The lever, which operates the switch, pivots in the switch mounting bracket and carries a conical tracer point which projects from its front face. An adjusting screw with lock-nut is provided to adjust the lever. A surface cam, conforming to the contour of the tail surfaces of the aeroplane, is carried on a slider which moves up and down the main pillar of the turret as the gun is elevated and depressed. The tracer point of the operating lever, making contact with the surface cam, operates the firing interrupter switch when the line of fire crosses the tail of the aeroplane.

Firing Switch and Change-over Mechanism

28. (*a*) The firing switch is on the main assembly bracket and is operated by a firing lever pivoted on a pin. The Bowden control from the air gunner's firing trigger is connected to the free end of the firing lever, between this and the pin being an adjusting screw to contact with the push button of the firing switch.

(*b*) The change-over mechanism is used when the electric circuit fails, and enables the air gunner to operate the gun firing valve direct by bringing it into mechanical connection with the firing trigger.

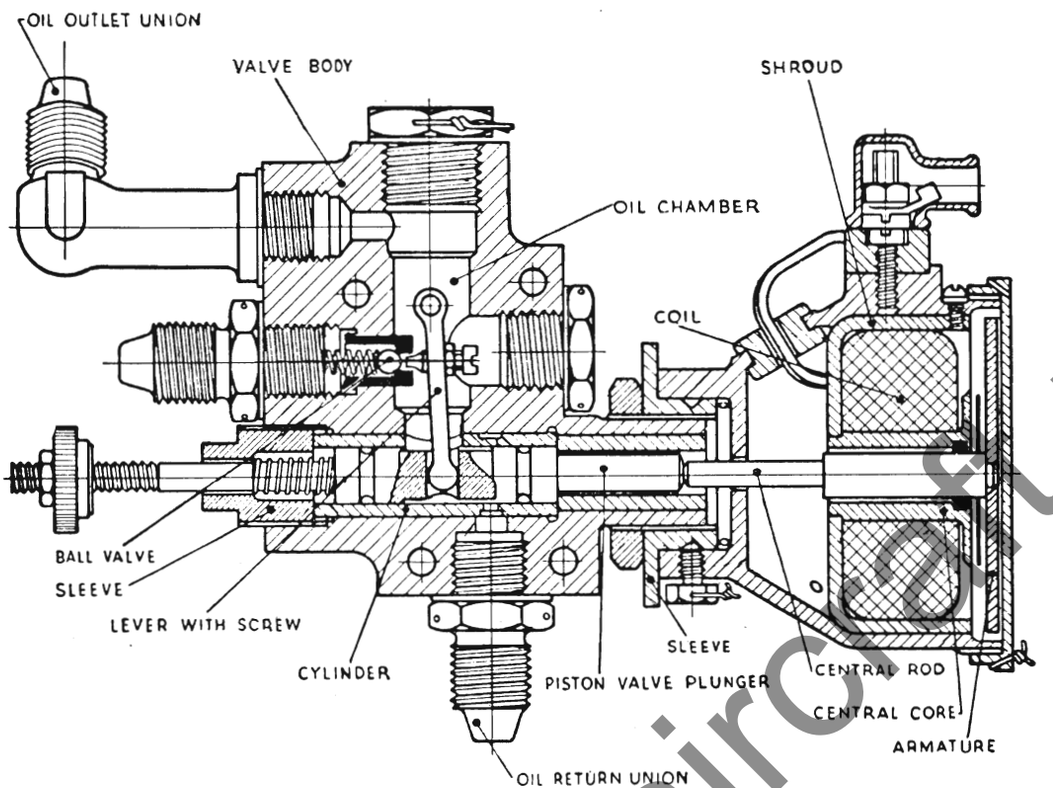
(*c*) The mechanism is controlled by a turn-button having two positions, 180° apart. The turn-button is mounted in large bearings and embodies an eccentric pin upon which a spring-loaded rocking lever oscillates. The rocking lever is permanently engaged with an extension on the firing lever.

(*d*) The piston valve plunger on the gun firing valve passes through a slot in the rocking lever, the plunger having an adjusting disc which makes contact with the rocking lever in one position of the turn-button only.

http://www.2aircraft.net/

plunger into position to close the ports in the cylinder liner and blank-off the passage to the oil return. At the same time, the piston valve plunger causes the lever to pivot on its pin and open the ball valve, thus admitting oil under pressure from the hydraulic accumulator to the oil chamber and to the sear release unit through the oil outlet union.

(*h*) When the firing switch is released, the spring returns the piston valve plunger, and the lever, returning to its normal position, allows the ball valve to close. At the same time the ports in the cylinder are opened and the oil chamber connected to the oil return pipe.



Gun firing valve and electro-magnet, sectional view

Hydraulic Accumulator

26. This is connected to the oil pipe leading from the top of the interrupter valve box to the gun firing valve of the electro-hydraulic firing mechanism. It consists of a cylinder containing a piston which is forced upwards by oil pressure so as to compress air pocketed above it to provide a reserve pressure which would enable the gun to be fired several times if the main hydraulic supply should fail.

Firing Interrupter Switch and Operating Mechanism

27. (*a*) The firing interrupter switch is a Burgess micro-switch Mark I of single-throw type and is mounted in a bracket on the main pillar of the turret. It is a sensitive component enclosed in a sealed dustproof moulded plastic body, and is connected in series with the firing switch and electro-magnet. A leaf spring operating tongue projects from the body and engages a lever on the switch mounting bracket. The holes in the mounting bracket plates, through which the eccentric switch securing bolt passes, are slotted to enable the interrupter switch to be adjusted.

(*b*) The lever, which operates the switch, pivots in the switch mounting bracket and carries a conical tracer point which projects from its front face. An adjusting screw with lock-nut is provided to adjust the lever. A surface cam, conforming to the contour of the tail surfaces of the aeroplane, is carried on a slider which moves up and down the main pillar of the turret as the gun is elevated and depressed. The tracer point of the operating lever, making contact with the surface cam, operates the firing interrupter switch when the line of fire crosses the tail of the aeroplane.

Firing Switch and Change-over Mechanism

28. (*a*) The firing switch is on the main assembly bracket and is operated by a firing lever pivoted on a pin. The Bowden control from the air gunner's firing trigger is connected to the free end of the firing lever, between this and the pin being an adjusting screw to contact with the push button of the firing switch.

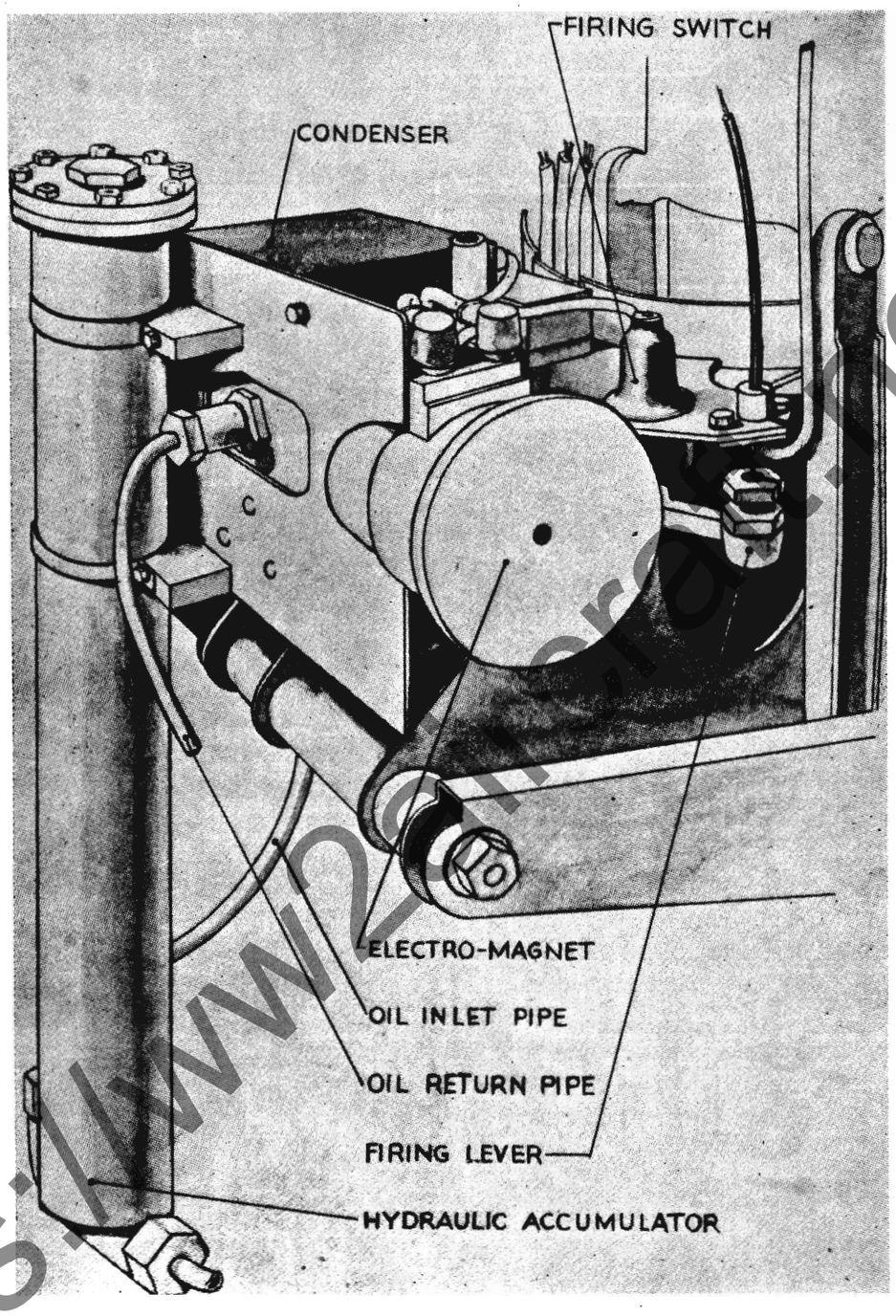
(*b*) The change-over mechanism is used when the electric circuit fails, and enables the air gunner to operate the gun firing valve direct by bringing it into mechanical connection with the firing trigger.

(*c*) The mechanism is controlled by a turn-button having two positions, 180° apart. The turn-button is mounted in large bearings and embodies an eccentric pin upon which a spring-loaded rocking lever oscillates. The rocking lever is permanently engaged with an extension on the firing lever.

(*d*) The piston valve plunger on the gun firing valve passes through a slot in the rocking lever, the plunger having an adjusting disc which makes contact with the rocking lever in one position of the turn-button only.

http://www.2aircraft.net/

(*c*) When the face of the turn-button marked "ELEC" is uppermost, the rocking lever is out of engagement with the disc. When the turn-button is rotated so that the face marked "MECH" is uppermost, the eccentric pin is moved and the rocking lever engages the disc. Mechanical motion can now be transmitted through the firing lever and rocking lever direct to the piston valve plunger of the gun firing valve.



Condenser and Terminal Boxes

29. A 0·25 microfarad condenser, mounted on the main assembly bracket, is connected in parallel with the interrupter micro-switch to prevent sparking at the contacts when the circuit is broken. Two terminal boxes are mounted on the main assembly bracket to facilitate the wiring of the electrical system.

FILLING THE HYDRAULIC SYSTEM

30. (*a*) When installing a turret, or any part of its hydraulic equipment, no attempt should be made to fill up the part with oil. The filling is always done through the hydraulic oil tank of the main hydraulic system.

(*b*) When the installation of the dry turret or of its hydraulic components is completed the turret should be operated several times throughout the complete range of its movement by oil pressure, either from the engine pump or the portable service pump. In this way air bubbles are forced along the return pipe and escape at the vent of the hydraulic oil tank. The system is filled with oil, lubricating, anti-freezing, Type A (Stores Ref. 34A/43 or 46).

https://www.2ndworldwar.net/

31. (*a*) When the master valve control lever is depressed, the Bowden cable operates the master valve which stops the flow of oil, and causes the oil pressure to increase between the engine driven gear pump and master valve to 600/700 lbs. per sq. inch in the Blenheim turret and 800 lbs. per sq. inch in the Beaufort turret.

(*b*) This pressure is available for use, any excess pressure is by-passed by the relief valve.

(*c*) When the master valve is released the pressure of the oil in the system decreases. No opration of the turret can take place until the master valve is operated.

(*d*) In the latest types of turrets a master valve assister lever is fitted to reduce fatigue in operation. The master valve control lever is actuated by an assister lever fitted with a hand stop and pivoted to one end of the control handle.

Elevation and Depression

32. (*a*) Vertical movements of the guns are obtained by rotating the control handles about their horizontal axis. By rotating the handles towards the gunner, the elevation valve is rotated through the valve into the hydraulic lock and the piston end of the elevation ram.

(*b*) The pressure entering the hydraulic lock bears on the rear of the valve piston and opens the valve.

(*c*) The pressure entering the top of the elevation ram shortens the ram and lowers the seat, which by linkage elevates the gun.

(*d*) The descending ram piston expels oil from the lower end of the ram; this oil is led by pipe line through the hydraulic lock to the elevation valve which directs it to the main exhaust pipe line.

(*e*) By turning the handles away from the gunner the pressure oil is directed to the central connection of the hydraulic lock, where the pressure opens the valve and allows the oil to flow to the base of the elevating ram which causes the piston to lift the seat, which, by linkage, depresses the gun.

(*b*) The ascending ram piston expels oil from the upper end of the ram, this oil is returned through the elevation valve to the main exhaust pipe line.

Turret Rotation

33. (*a*) Rotation of the control handles to the right or left causes the turret rotation valve to be operated, which directs the pressure oil to one end of the rotation cam, rotating the turret in the corresponding direction of the movement of the control handles.

(*b*) Oil expelled from the exhaust side of the rotation ram piston is directed through the rotation valve to the main exhaust pipe line.

(*c*) Independent gun rotation (Blenheim).

(i) When the right or left pedal is depressed the gun rotation valve directs oil to one end of the gun rotation ram, rotating the gun in the corresponding direction.

(ii) On depressing the foot pedal the locking plunger is disengaged from the quadrant on the gun pillar, on releasing the pedal the spring-loaded plunger takes up a position in one of the five holes in the quadrant.

34. The gun or guns are fired by a trigger lever, which is fitted to the right-hand grip of the control handles.

35. The hydraulic lock normally functions automatically, but a lever for foot or hand operation is provided in case the pressure oil fails when the seat is fully elevated. This lever is pressed outwards to render the lock ineffective and thus permits the seat to descend under the air gunner's weight.

36. Before operating the Blenheim turret the cupola must be raised to its fullest extent and locked in that position by engaging the hand operated lock slide which engages with the teeth of the operating handle pinion gear. Also the wind excluding panels, if fitted, must be opened to allow for the movements of the gun.

37. The oxygen supply, intercommunication and wireless socket connections for the air gunner are to be found on the starboard side of the aeroplane adjacent to the turret.

38. The electric supply for gun sight, etc., is brought into the turret through a flexible circuit from terminal blocks in the aeroplane near the turret. A switch is provided for each supply on the side of the aeroplane; the electrical socket connections for the gun sight, etc., are fitted within the turret.

39. With some turrets, a turret isolating valve is fitted to the starboard side of the aeroplane.

(*a*) It is used to short circuit the hydraulic system in the turret, if a pipe breakage occurs, and to maintain the circulation in the main hydraulic when the turret is removed.

(*b*) The valve is operated by a remote control lever. The "ON" and "OFF" positions are indicated.

(*c*) An instruction plate is fitted which reads:—"Push handle down through 90° to cut off power supply to turret if pipe line bursts. No return to 'ON' position from this end of the system."

The Load Test of the Solenoid

The plunger is to move a distance of $\frac{1}{16}$ inch before lifting a weight of 9 lbs., a further $\frac{1}{16}$ inch, using 18 volts. The plunger has only one-eighth movement.

https://www.2aircraft.net/

To Adjust the Gun Firing Mechanism

Set the switch pin of the cam control to "Mech". Adjust the knurled nut on valve spindle until there is approximately ·005 clearance between the humps on the rocking arm and the knurled adjusting nut. Then set cam control to "Elect." and operate trigger. The press button firing switch should close fully and rocking arm should not move valve plunger. If it does, screw press button adjusting bolt on the firing lever up until the correct setting is obtained. Always ensure the plunger valve is in the fully closed position when making these adjustments. The trigger bowden wire is to be adjusted so that the lever starts to operate as soon as the trigger is moved. With the cam control set to "Mech" care must be taken not to fire into the tail units of the aircraft as the gun firing interrupter micro switch is out of operation.

Adjustment and Setting of Firing Interrupter

(1) Firstly be sure to adjust tracer bracket parallel to column by adjusting 6 B.A. screw in bottom of same.

(2) Check micro switch to see that it works correctly and efficiently.

(3) Set micro switch by adjusting eccentric screw so that the solenoid operates when tracer bracket is full forward.

(4) Depress gun until slider comes opposite tracer point, then bend micro switch mounting bracket until tracer point is $\frac{1}{64}$ inch from slider.

(5) Operate turret carefully to see tracer point does not catch in image.

(6) Check on elevators to see if solenoid cuts off evenly on top and bottom and if not move tracer point in the desired direction in vertical slot of tracer bracket.

(7) Check on rudder to see if solenoid cuts off evenly, if not move micro switch bracket in the desired horizontal position after first slacking off the four holding screws in the top bearing.

(8) A faulty micro switch can be checked by bridging terminals 1 and 3 in block on firing unit.

(9) A faulty press button switch in firing unit can be checked by bridging terminals 1 and 2 in block on firing unit. Trigger need not be pressed.

(10) A faulty supply line can be checked by bridging terminals 2 and 4 with a 24-volt lamp.

(11) If solenoid does not work arc across, terminals 1 and 3 for micro switch with the trigger pressed.

(12) The starboard elevators image should be flush with the slider. If not bend image down until it is. There should be no sharp edges on the image as these will catch on the tracer point and bend the tracer bracket.

(13) In the event of electrical supply failure the guns can be fired manually by turning the operating lever cam pin through 180° to "Mech". Guns can also be operated by means of the hand rams that are stowed in the turret cupola.

APPROXIMATE CONTROL LINKAGE SETTINGS

Rotation Control Linkage.—$2\frac{9}{16}$ in. centre to centre.
Elevation Control Link.—$2\frac{5}{16}$ in. centre to centre.
Clip-on Spring Control.—$1\frac{1}{8}$ in. from top of clip to top of spring control.
End Fitting on Operating Plunger.—$\frac{5}{32}$ in. from top of locknut to bottom shoulder of end fitting.

BOWDEN CABLE LENGTHS

Master Cable.—Outer: 2 ft. $6\frac{1}{2}$ in.; Inner: 2 ft. 9 in.
Trigger Cable.—Outer: 2 ft. 4 in.; Inner: 2 ft. $7\frac{1}{4}$ in.
Interrupter Cable.—Outer: 1 ft. $10\frac{1}{2}$ in.; Inner: 2 ft. $2\frac{3}{8}$ in.
All outer cable lengths are given with ferrules fitted.
All inner cable lengths are given including nipples.

CARE AND MAINTENANCE

40. (*a*) Full instructions for dismantling, assembling, testing and repair are to be found in A.P.1659B, Vols. 1 and 2, Bristol gun turrets.

(*b*) All working parts of the turret should be kept free from rust and corrosion. They should be lubricated with oil, lubricating, anti-freezing, Type "A" and grease, anti-freezing. A lubrication chart will be found for each turret in A.P. 1659B, Bristol gun turrets.

(*c*) The transparent panels of the cupola should be kept clean and free from scratches. The reflector gun sight should be tested and cleaned before use.

(*d*) Air gunners should be instructed to operate the turret frequently under extremely low temperature conditions, as by such operaton the liquid becomes warmed and partial freezing up is avoided. The operation of the turret should be conducted throughout its full range of transverse including elevation and depression of the guns, in order to remove any congealing fluid collecting in any part of the mechanism.

(*e*) Inspect the turret and components for damage and leaks. Inspect the pipe lines for leakage, especially the flexible pipe connections to the sear release unit, and the swivel joints.

(*f*) Examine all controls and mechanisms for correct adjustment and functioning.

(*g*) The gun firing and interrupter Bowden cables should be inspected for security, lubrication and correct adjustment.

https://www.2aircraft.net/

To Adjust the Gun Firing Mechanism

Set the switch pin of the cam control to "Mech". Adjust the knurled nut on valve spindle until there is approximately ·005 clearance between the humps on the rocking arm and the knurled adjusting nut. Then set cam control to "Elect." and operate trigger. The press button firing switch should close fully and rocking arm should not move valve plunger. If it does, screw press button adjusting bolt on the firing lever up until the correct setting is obtained. Always ensure the plunger valve is in the fully closed position when making these adjustments. The trigger bowden wire is to be adjusted so that the lever starts to operate as soon as the trigger is moved. With the cam control set to "Mech" care must be taken not to fire into the tail units of the aircraft as the gun firing interrupter micro switch is out of operation.

Adjustment and Setting of Firing Interrupter

(1) Firstly be sure to adjust tracer bracket parallel to column by adjusting 6 B.A. screw in bottom of same.

(2) Check micro switch to see that it works correctly and efficiently.

(3) Set micro switch by adjusting eccentric screw so that the solenoid operates when tracer bracket is full forward.

(4) Depress gun until slider comes opposite tracer point, then bend micro switch mounting bracket until tracer point is $\frac{1}{64}$ inch from slider.

(5) Operate turret carefully to see tracer point does not catch in image.

(6) Check on elevators to see if solenoid cuts off evenly on top and bottom and if not move tracer point in the desired direction in vertical slot of tracer bracket.

(7) Check on rudder to see if solenoid cuts off evenly, if not move micro switch bracket in the desired horizontal position after first slacking off the four holding screws in the top bearing.

(8) A faulty micro switch can be checked by bridging terminals 1 and 3 in block on firing unit.

(9) A faulty press button switch in firing unit can be checked by bridging terminals 1 and 2 in block on firing unit. Trigger need not be pressed.

(10) A faulty supply line can be checked by bridging terminals 2 and 4 with a 24-volt lamp.

(11) If solenoid does not work arc across, terminals 1 and 3 for micro switch with the trigger pressed.

(12) The starboard elevators image should be flush with the slider. If not bend image down until it is. There should be no sharp edges on the image as these will catch on the tracer point and bend the tracer bracket.

(13) In the event of electrical supply failure the guns can be fired manually by turning the operating lever cam pin through 180° to "Mech". Guns can also be operated by means of the hand rams that are stowed in the turret cupola.

APPROXIMATE CONTROL LINKAGE SETTINGS

Rotation Control Linkage.—$2\frac{9}{16}$ in. centre to centre.
Elevation Control Link.—$2\frac{5}{16}$ in. centre to centre.
Clip-on Spring Control.—$1\frac{1}{8}$ in. from top of clip to top of spring control.
End Fitting on Operating Plunger.—$\frac{5}{32}$ in. from top of locknut to bottom shoulder of end fitting.

BOWDEN CABLE LENGTHS

Master Cable.—Outer: 2 ft. $6\frac{1}{2}$ in.; Inner: 2 ft. 9 in.
Trigger Cable.—Outer: 2 ft. 4 in.; Inner: 2 ft. $7\frac{1}{4}$ in.
Interrupter Cable.—Outer: 1 ft. $10\frac{1}{2}$ in.; Inner: 2 ft. $2\frac{3}{8}$ in.
All outer cable lengths are given with ferrules fitted.
All inner cable lengths are given including nipples.

CARE AND MAINTENANCE

40. (*a*) Full instructions for dismantling, assembling, testing and repair are to be found in A.P.1659B, Vols. 1 and 2, Bristol gun turrets.

(*b*) All working parts of the turret should be kept free from rust and corrosion. They should be lubricated with oil, lubricating, anti-freezing, Type "A" and grease, anti-freezing. A lubrication chart will be found for each turret in A.P. 1659B, Bristol gun turrets.

(*c*) The transparent panels of the cupola should be kept clean and free from scratches. The reflector gun sight should be tested and cleaned before use.

(*d*) Air gunners should be instructed to operate the turret frequently under extremely low temperature conditions, as by such operaton the liquid becomes warmed and partial freezing up is avoided. The operation of the turret should be conducted throughout its full range of transverse including elevation and depression of the guns, in order to remove any congealing fluid collecting in any part of the mechanism.

(*e*) Inspect the turret and components for damage and leaks. Inspect the pipe lines for leakage, especially the flexible pipe connections to the sear release unit, and the swivel joints.

(*f*) Examine all controls and mechanisms for correct adjustment and functioning.

(*g*) The gun firing and interrupter Bowden cables should be inspected for security, lubrication and correct adjustment.

https://ww2aircraft.net/

(*h*) Inspect gun or guns, attachments, mountings, ammunition boxes, feed rollers, shutes, containers, etc., for security, etc., and correct functioning.

(*i*) Check harmonization of guns and sight. Test electric connections, intercommunication system, oxygen supply, etc.

(*j*) Ensure that the necessary tools are in their correct stowage.

(*k*) Before flight the ammunition should be checked for cleanliness, type and quantity.

(*l*) The firing interrupter switch gear must always be adjusted so that the electrical circuit is broken when the tracer point makes contact with the cam. All electrical apparatus to be kept free from oil.

FAULTY FUNCTIONING OF TURRETS

41. (*a*) Leakage of oil may be due to:—

Pipe fracture, gland leakage, union nuts loose, leakage past the covers of the hydraulic ram or valve box.

Remedy: Renew pipe, glands or packings, tighten union nuts, etc.

(*b*) Failure of turret to respond to controls when master valve is depressed:—
Failure of oil supply, incorrect adjustment of Bowden control, seizure of master valve.
Remedy: Check oil supply, adjust or repair where necessary.

(*c*) Failure of master valve to stop turret movement when lever is released:—
Broken return spring or seizure of valve.
Remedy: Renew spring, repair valve.

(*d*) Failure of turret or gun rotation control:—

Airlock in system, incorrect adjustment of control, or couplings loose, control valve seizing.

Remedy: Operate control in appropriate direction, move turret or gun by hand to displace the air, adjust controls, repair control valve.

(*e*) Faulty gun elevation control:—

Air-lock in system, broken internal spring in telescopic control tube, seizure of control valve, ram piston cup washers leaking, broken or loose linkage, hydraulic lock faults.

Remedy: Displace air or repair where necessary.

(*f*) Excessive "creep" of turret or gun rotation mechanism when controls are in neutral position:—

Ram piston cup washers leaking or control valve worn.
Remedy: Repair where necessary.

(*g*) Seat descends under air gunner's weight when controls are in neutral position:—
Cup washers on elevation ram piston leaking, control valve worn, faulty hydraulic lock.
Remedy: Repair where necessary.

(*h*) Failure of centralizing gear to return turret rotation control to mid-position:—
Plungers or springs distorted, sticking or broken.
Remedy: Lubricate, repair or renew damaged parts.

(*i*) Failure of hydraulic system to hold up seat when elevation control is centralized:—

(i) Broken poppet valve spring.
(ii) Poppet valve not seating, due to insufficient clearance between push rod and floating piston.
(iii) Piston sticking and preventing valve from seating.
(iv) Push rod sticking in gland.
(v) Push rod return spring broken.

Remedy: (i) New poppet valve spring.
(ii) Increase clearance by screwing in the adjusting screw at the inner end of the push rod.
(iii) Dismantle and clean lock.
(iv) Dismantle gland, clean, and renew any broken parts.
(v) Renew return spring.

(*j*) Failure of hydraulic lock to allow seat to descend when controls are set to elevate gun:—

(i) Piston sticking at push end of stroke and not moving across to lift poppet valve.
(ii) Worn piston or cylinder allowing oil to pass through lock without displacing piston.

Remedy: (i) Dismantle and clean lock.
(ii) Renew piston and/or cylinder liner.

(*k*) Failure of hydraulic lock to allow seat to descend when operated by foot lever:—

(i) Adjusting screw on push rod broken, or screwed in too far.
(ii) Piston sticking.

Remedy: (i) Renew and/or adjust screw.
(ii) Dismantle and clean lock.

(*l*) Maximum speeds of turret or gun rotation in both directions unequal. Maximum speeds of gun elevation and depression unequal. This may be due to:—
Incorrect adjustment of control rods or linkage.
Remedy: Adjust as necessary.

(*m*) Stiff rotation of turret may be due to:—
Rollers of turret top bearing sticking or incorrect alignment of roller ring.
Remedy: Clean and lubricate rollers or realign.

https://ww2aircraft.net/

(*h*) Inspect gun or guns, attachments, mountings, ammunition boxes, feed rollers, shutes, containers, etc., for security, etc., and correct functioning.

(*i*) Check harmonization of guns and sight. Test electric connections, intercommunication system, oxygen supply, etc.

(*j*) Ensure that the necessary tools are in their correct stowage.

(*k*) Before flight the ammunition should be checked for cleanliness, type and quantity.

(*l*) The firing interrupter switch gear must always be adjusted so that the electrical circuit is broken when the tracer point makes contact with the cam. All electrical apparatus to be kept free from oil.

FAULTY FUNCTIONING OF TURRETS

41. (*a*) Leakage of oil may be due to:—

Pipe fracture, gland leakage, union nuts loose, leakage past the covers of the hydraulic ram or valve box.

Remedy: Renew pipe, glands or packings, tighten union nuts, etc.

(*b*) Failure of turret to respond to controls when master valve is depressed:—
Failure of oil supply, incorrect adjustment of Bowden control, seizure of master valve.
Remedy: Check oil supply, adjust or repair where necessary.

(*c*) Failure of master valve to stop turret movement when lever is released:—
Broken return spring or seizure of valve.
Remedy: Renew spring, repair valve.

(*d*) Failure of turret or gun rotation control:—

Airlock in system, incorrect adjustment of control, or couplings loose, control valve seizing.

Remedy: Operate control in appropriate direction, move turret or gun by hand to displace the air, adjust controls, repair control valve.

(*e*) Faulty gun elevation control:—

Air-lock in system, broken internal spring in telescopic control tube, seizure of control valve, ram piston cup washers leaking, broken or loose linkage, hydraulic lock faults.

Remedy: Displace air or repair where necessary.

(*f*) Excessive "creep" of turret or gun rotation mechanism when controls are in neutral position:—

Ram piston cup washers leaking or control valve worn.
Remedy: Repair where necessary.

(*g*) Seat descends under air gunner's weight when controls are in neutral position:—
Cup washers on elevation ram piston leaking, control valve worn, faulty hydraulic lock.
Remedy: Repair where necessary.

(*h*) Failure of centralizing gear to return turret rotation control to mid-position:—
Plungers or springs distorted, sticking or broken.
Remedy: Lubricate, repair or renew damaged parts.

(*i*) Failure of hydraulic system to hold up seat when elevation control is centralized:—

(i) Broken poppet valve spring.
(ii) Poppet valve not seating, due to insufficient clearance between push rod and floating piston.
(iii) Piston sticking and preventing valve from seating.
(iv) Push rod sticking in gland.
(v) Push rod return spring broken.

Remedy: (i) New poppet valve spring.
(ii) Increase clearance by screwing in the adjusting screw at the inner end of the push rod.
(iii) Dismantle and clean lock.
(iv) Dismantle gland, clean, and renew any broken parts.
(v) Renew return spring.

(*j*) Failure of hydraulic lock to allow seat to descend when controls are set to elevate gun:—

(i) Piston sticking at push end of stroke and not moving across to lift poppet valve.
(ii) Worn piston or cylinder allowing oil to pass through lock without displacing piston.

Remedy: (i) Dismantle and clean lock.
(ii) Renew piston and/or cylinder liner.

(*k*) Failure of hydraulic lock to allow seat to descend when operated by foot lever:—

(i) Adjusting screw on push rod broken, or screwed in too far.
(ii) Piston sticking.

Remedy: (i) Renew and/or adjust screw.
(ii) Dismantle and clean lock.

(*l*) Maximum speeds of turret or gun rotation in both directions unequal. Maximum speeds of gun elevation and depression unequal. This may be due to:—
Incorrect adjustment of control rods or linkage.
Remedy: Adjust as necessary.

(*m*) Stiff rotation of turret may be due to:—
Rollers of turret top bearing sticking or incorrect alignment of roller ring.
Remedy: Clean and lubricate rollers or realign.

https://www.2aircraft.net/

(*o*) Failure of interrupter gear:—

Broken Bowden cable, incorrect adjustment of cable, damaged linkage.

Remedy: Repair or adjust as necessary.

(*p*) The accumulator piston may be forced up to the top of the cylinder in the event of an air leakage. This will usually be the cause of delayed action of the gun firing rams.

Remedy: Take off top plate of the plug on the top of the accumulator and force piston down to the bottom of the cylinder. See that there is a film of oil on top of the piston before replacing the top plate. Find and repair the leak in the top of the accumulator.

NOTE.—Apart from the stoppages laid down for Vickers G.O. guns and Browning guns fitted to the Blenheim turret, type B1, Mark IV, the following faults may occur:—

(*p*) Gun or guns fail to fire:—

(i) Broken Bowden cable, seizure or incorrect adjustment of cable.
(ii) Failure of electrical hydraulic supply.
(iii) Firing switch not making contact.
(iv) Plunger of gun firing valve seized.
(v) Central rod of magnet seizing.
(vi) Interrupter switch faulty.
(vii) Break or short circuit in connecting wires or condenser.
(viii) Breakdown of magnet coil.
(ix) Faulty attachment of sear release unit.
(x) Internal fault in gun firing valve.

Remedy: Renew, adjust or repair necessary part.

(*q*) Gun or guns stop firing.

(i) Broken Bowden cable.
(ii) Failure of electrical or hydraulic supply.
(iii) Internal fault in gun firing valve.
(iv) Faulty attachment of sear release unit.
(v) Break in connecting wires, faulty contact of switches, etc.

Remedy: Repair, adjust where necessary.

(*r*) Runaway gun or guns:—

(i) Seized Bowden cable or levers.
(ii) Seized plunger or broken return spring in gun firing valve.
(iii) Faulty firing button switch.
(iv) Broken ball valve spring in gun firing valve, jamming valve, open, or dirt in ball valve seat.
(v) Seizure of sear release unit plunger or hydraulic ram.

Remedy: Repair or adjust where necessary.

GUN INSTALLATION

Blenheim Gun Turret Mark III

42. (*a*) A single Vickers G.O. ·303-inch gun is attached to the gun chassis in an upright position. The front end of the gun body is connected to the chassis by a quick release pin. The rear end of the gun has a back plate bolted to it provided with lugs having special bolts which engage with slots at the near end of the chassis. Knurled headed nuts are provided for these bolts.

(*b*) A bracket plate shaped to enclose and protect the firing gear of the gun and is surmounted by a chin pad secured to the back plate.

(*c*) The gun sight is carried on a special bracket which is held in a dovetailed slot at the side of the gun body.

(*d*) Provision is made for spent cartridges by an aluminium container of special shape supported at the deflector neck of the gun by means of a hook plate device with a spring catch, enabling the component to be removed quickly for transfer of empty cases to the bulk container. No bottom door is provided in this component.

(*e*) In some cases an armoured plate is fitted to the rear of the gun for protection of the gunner. A slot in the armour plate is provided for sighting purposes.

Beaufort Centre Gun Turret Mark I

43. (*a*) A single Vickers G.O. ·303-inch gun is mounted on its side and is attached to the cradle by a quick release pin at the front and a thumb screw at the rear.

(*b*) The reflector gun sight and bracket is mounted on the gun, a chin pad and adjustable cheek pad are mounted on brackets on the gun cradle.

(*c*) The barrel of the gun projects through a sealed gun slot with sufficient clearance to permit the withdrawal of the gun without dismantling the gun slot seal.

(*d*) A magazine guide, which is clamped to the gun, locates the magazine in the correct position for engaging the magazine catch plates with the catches on the gun.

(*e*) An empty cartridge case container is carried on the turret frame at deck height.

(i) It has four sliding doors for removal of the empty cases, and carries two panels of armour plate to protect the air gunner.

https://www.2aircraft.net/

(*o*) Failure of interrupter gear:—

Broken Bowden cable, incorrect adjustment of cable, damaged linkage.

Remedy: Repair or adjust as necessary.

(*p*) The accumulator piston may be forced up to the top of the cylinder in the event of an air leakage. This will usually be the cause of delayed action of the gun firing rams.

Remedy: Take off top plate of the plug on the top of the accumulator and force piston down to the bottom of the cylinder. See that there is a film of oil on top of the piston before replacing the top plate. Find and repair the leak in the top of the accumulator.

NOTE.—Apart from the stoppages laid down for Vickers G.O. guns and Browning guns fitted to the Blenheim turret, type B1, Mark IV, the following faults may occur:—

(*p*) Gun or guns fail to fire:—

(i) Broken Bowden cable, seizure or incorrect adjustment of cable.
(ii) Failure of electrical hydraulic supply.
(iii) Firing switch not making contact.
(iv) Plunger of gun firing valve seized.
(v) Central rod of magnet seizing.
(vi) Interrupter switch faulty.
(vii) Break or short circuit in connecting wires or condenser.
(viii) Breakdown of magnet coil.
(ix) Faulty attachment of sear release unit.
(x) Internal fault in gun firing valve.

Remedy: Renew, adjust or repair necessary part.

(*q*) Gun or guns stop firing.

(i) Broken Bowden cable.
(ii) Failure of electrical or hydraulic supply.
(iii) Internal fault in gun firing valve.
(iv) Faulty attachment of sear release unit.
(v) Break in connecting wires, faulty contact of switches, etc.

Remedy: Repair, adjust where necessary.

(*r*) Runaway gun or guns:—

(i) Seized Bowden cable or levers.
(ii) Seized plunger or broken return spring in gun firing valve.
(iii) Faulty firing button switch.
(iv) Broken ball valve spring in gun firing valve, jamming valve, open, or dirt in ball valve seat.
(v) Seizure of sear release unit plunger or hydraulic ram.

Remedy: Repair or adjust where necessary.

GUN INSTALLATION

Blenheim Gun Turret Mark III

42. (*a*) A single Vickers G.O. ·303-inch gun is attached to the gun chassis in an upright position. The front end of the gun body is connected to the chassis by a quick release pin. The rear end of the gun has a back plate bolted to it provided with lugs having special bolts which engage with slots at the near end of the chassis. Knurled headed nuts are provided for these bolts.

(*b*) A bracket plate shaped to enclose and protect the firing gear of the gun and is surmounted by a chin pad secured to the back plate.

(*c*) The gun sight is carried on a special bracket which is held in a dovetailed slot at the side of the gun body.

(*d*) Provision is made for spent cartridges by an aluminium container of special shape supported at the deflector neck of the gun by means of a hook plate device with a spring catch, enabling the component to be removed quickly for transfer of empty cases to the bulk container. No bottom door is provided in this component.

(*e*) In some cases an armoured plate is fitted to the rear of the gun for protection of the gunner. A slot in the armour plate is provided for sighting purposes.

Beaufort Centre Gun Turret Mark I

43. (*a*) A single Vickers G.O. ·303-inch gun is mounted on its side and is attached to the cradle by a quick release pin at the front and a thumb screw at the rear.

(*b*) The reflector gun sight and bracket is mounted on the gun, a chin pad and adjustable cheek pad are mounted on brackets on the gun cradle.

(*c*) The barrel of the gun projects through a sealed gun slot with sufficient clearance to permit the withdrawal of the gun without dismantling the gun slot seal.

(*d*) A magazine guide, which is clamped to the gun, locates the magazine in the correct position for engaging the magazine catch plates with the catches on the gun.

(*e*) An empty cartridge case container is carried on the turret frame at deck height.

(i) It has four sliding doors for removal of the empty cases, and carries two panels of armour plate to protect the air gunner.

https://www.2aircraft.net/

(ii) The empty cases are ejected from the gun into the container through a shute made up of sections which swing on the gun cradle hinge point as the gun is elevated or depressed.

(*f*) A slotted armour plate face guard is fitted to the gun cradle.

The Beaufort Centre Gun Turret Mark IE

44. (*a*) Two Vickers G.O. ·303-inch guns are fitted to this turret. The right-hand gun mounting is the same as in the Beaufort Mark I turret. The left-hand gun is mounted upright on the side of the gun cradle. The left-hand gun's front attachment comprises a bracket carrying a forked swivel, to which the gun is anchored by a quick-release pin.

(*b*) The rear attachment comprises a hinge bracket pivoted between lugs on a bracket bolted to the side of the gun cradle.

(c) The gun is held by a gun attachment bracket connected to the hinge bracket by a crossed dove-tailed slide, which provides adjustment in elevation and azimuth. Elevation and azimuth adjustment screws with knurled heads and lock-nuts are used for making these adjustments. The dove-tailed slide, the gun attachment and hinge bracket are locked together, in a position adjusted for elevation or azimuth, by clamping bolts provided with lock-nuts.

(*d*) When the gun is adjusted in azimuth, the centre line of the rear mounting bolt moves out of alignment with the transverse centre line of the gun attachment bracket.

(*e*) To obviate this, the angle of the hinge bracket can be adjusted by two knurled nuts on a bolt pivoted on the fixed bracket and extending through the hinge bracket. These two nuts hold the hinged bracket in a position adjuster for azimuth.

(*f*) The left-hand gun's empty cartridges case chute is similar to that for the right-hand. Its upper end is fixed to the gun cradle and embraces the deflector neck for the gun. The empty cartridge container has an additional chute similar to that for the right-hand gun.

(*g*) The gun slot seal has an additional hole to admit the barrel of the left-hand gun. The shape of the face guard is modified to clear the left-hand gun.

The Blenheim 1 and 1V Centre Gun Turret, Type B1, Mark IV

45. (*a*) This turret is similar in construction and operation to the Blenheim turret Mark III. In place of the single Vickers G.O. gun, two Browning guns are mounted in an upright position to the gun cradle.

(*b*) Brackets on vertical pivots and quick-release pins support the guns in front, and the rear attachments provide for elevation and azimuth adjustments for harmonizing the guns.

NOTE.—A modification is under way to transfer elevation and azimuth adjustments for harmonizing the guns from the rear to the front bracket.

(*c*) A face guard and reflector gun sight is fitted on the gun cradle at the rear of the guns.

(*d*) This turret is fitted with an electro-hydraulic gun firing control mechanism. With gun fire interrupter (guns firing simultaneously), hand operated fire and safe units are fitted.

(*e*) In addition to the reflector gun sight, which is fitted to a slotted anchorage on the face guard plate opposite the air gunner's right eye, ring and bead sights for alternative use are clamped to the barrel of the left-hand gun, in line with his left eye.

(*f*) The guns are fitted with feed necks, empty cartridge case and belt link chutes. Two 950-round capacity ammunition boxes are fixed to the cupola guide tubes by hinged clips held by thumb screws. The empty cartridge bases and belt links are discharged through their shute into the empty case container which is fixed to the turret to rotate with it. The top of the container has a transparent inspection panel and the curved side has a sliding door for removing the contents.

(*g*) The hydraulic oil pressure (600/700 lbs. per sq. in.) and the field of fire (azimuth total 200°, elevation 60°, and depression 32°) are the same as in the Blenheim turret Mark III.

CENTRE GUN TURRET (BEAUFORT)

https://ww2aircraft.net/

(ii) The empty cases are ejected from the gun into the container through a shute made up of sections which swing on the gun cradle hinge point as the gun is elevated or depressed.

(*f*) A slotted armour plate face guard is fitted to the gun cradle.

The Beaufort Centre Gun Turret Mark IE

44. (*a*) Two Vickers G.O. ·303-inch guns are fitted to this turret. The right-hand gun mounting is the same as in the Beaufort Mark I turret. The left-hand gun is mounted upright on the side of the gun cradle. The left-hand gun's front attachment comprises a bracket carrying a forked swivel, to which the gun is anchored by a quick-release pin.

(*b*) The rear attachment comprises a hinge bracket pivoted between lugs on a bracket bolted to the side of the gun cradle.

(c) The gun is held by a gun attachment bracket connected to the hinge bracket by a crossed dove-tailed slide, which provides adjustment in elevation and azimuth. Elevation and azimuth adjustment screws with knurled heads and lock-nuts are used for making these adjustments. The dove-tailed slide, the gun attachment and hinge bracket are locked together, in a position adjusted for elevation or azimuth, by clamping bolts provided with lock-nuts.

(*d*) When the gun is adjusted in azimuth, the centre line of the rear mounting bolt moves out of alignment with the transverse centre line of the gun attachment bracket.

(*e*) To obviate this, the angle of the hinge bracket can be adjusted by two knurled nuts on a bolt pivoted on the fixed bracket and extending through the hinge bracket. These two nuts hold the hinged bracket in a position adjuster for azimuth.

(*f*) The left-hand gun's empty cartridges case chute is similar to that for the right-hand. Its upper end is fixed to the gun cradle and embraces the deflector neck for the gun. The empty cartridge container has an additional chute similar to that for the right-hand gun.

(*g*) The gun slot seal has an additional hole to admit the barrel of the left-hand gun. The shape of the face guard is modified to clear the left-hand gun.

The Blenheim 1 and 1V Centre Gun Turret, Type B1, Mark IV

45. (*a*) This turret is similar in construction and operation to the Blenheim turret Mark III. In place of the single Vickers G.O. gun, two Browning guns are mounted in an upright position to the gun cradle.

(*b*) Brackets on vertical pivots and quick-release pins support the guns in front, and the rear attachments provide for elevation and azimuth adjustments for harmonizing the guns.

NOTE.—A modification is under way to transfer elevation and azimuth adjustments for harmonizing the guns from the rear to the front bracket.

(*c*) A face guard and reflector gun sight is fitted on the gun cradle at the rear of the guns.

(*d*) This turret is fitted with an electro-hydraulic gun firing control mechanism. With gun fire interrupter (guns firing simultaneously), hand operated fire and safe units are fitted.

(*e*) In addition to the reflector gun sight, which is fitted to a slotted anchorage on the face guard plate opposite the air gunner's right eye, ring and bead sights for alternative use are clamped to the barrel of the left-hand gun, in line with his left eye.

(*f*) The guns are fitted with feed necks, empty cartridge case and belt link chutes. Two 950-round capacity ammunition boxes are fixed to the cupola guide tubes by hinged clips held by thumb screws. The empty cartridge bases and belt links are discharged through their shute into the empty case container which is fixed to the turret to rotate with it. The top of the container has a transparent inspection panel and the curved side has a sliding door for removing the contents.

(*g*) The hydraulic oil pressure (600/700 lbs. per sq. in.) and the field of fire (azimuth total 200°, elevation 60°, and depression 32°) are the same as in the Blenheim turret Mark III.

CENTRE GUN TURRET (BEAUFORT)

https://www.2aircraft.net/

PART III

BOULTON PAUL GUN TURRETS

Introduction

1. (*a*) There are several types of Boulton Paul gun turrets, which differ in arrangement according to the services required of them, but they are similar in general design.

(*b*) In all Boulton Paul gun turrets, a power operated electro-hydraulic system is used and the air gunner is provided with constant power for training the guns under all conditions.

(*c*) The method of turret operation is similar in all cases and is entirely self contained. The necessary electricity supply is taken through a slip ring from a 24-volt D.C. 1,000-watt generator on the aero-engine.

(*d*) The only turret connections to the airframe are the holding down bolts and the connections to the electric distributor, consequently a complete turret can be removed without breaking the pipe joints or disturbing any thing other than the electrical connections. This system permits turrets to be fully tested before installation in the aircraft.

(*e*) The turret movements are coupled to the hydraulic system so that rotation and elevation can only be effected by the control column; external forces, recoil, etc., have no effect on the turret.

(*f*) Provision is made to release the turret from the hydraulic system so that it can be manually operated for servicing purposes, but while the turret is free, firing is automatically prevented.

(*g*) Protective devices are fitted to the turret:—

(i) Firing ceases automatically when the line of fire approaches interfering portions of the aeroplane.

(ii) In cases where the turret is installed centrally and fairings are fitted, the fairings are made to retract automatically on approach of the gun barrels.

(iii) When the turret is mounted centrally in the aeroplane, an interlock device is fitted to prevent fouling of the gun barrels on the adjoining fuselage.

(*h*) In the majority of turrets the guns are remote from the air-gunner's eye level, making direct sighting impossible. A reflector sight is mounted at a height convenient to the air-gunner's eye level and is so arranged that it is elevated and depressed with the guns by means of a link and lever system.

(*i*) The limits of rotational movement of the turret vary with the particular aircraft or turret. On some turrets it is possible to obtain complete and continuous rotation; others permit only partial rotation.

(*j*) The purpose of the hydraulic system is to distribute power through two closed circuits, each supplied by pressure oil from one of the generator pumps, to the various components installed in the turret.

(*k*) With most turrets, radio interference suppressors, electrical intercommunication and oxygen supply are fitted.

GENERAL DESCRIPTION OF COMPONENT PARTS AND THEIR FUNCTIONS

Electrical Distributor

2. (*a*) As the turret is capable of rotation a brush and slip ring distributor is fitted beneath the turret.

(*b*) Slip rings are fitted to the distributor to convey the current obtained from the aero-engine generator for current operation. Connections for intercommunication, lighting, gun firing, etc., are also fitted.

(*c*) Connections are taken from the distributor terminals to a master terminal block and from these, through conduits, to the various distribution points in the turret.

(*d*) Functions of the electrical distributor are to supply the turret with the necessary electrical current, at the same time allowing the turret to rotate.

The Electric Motor and Reduction Gear

3. (*a*) The electric motor is a totally enclosed, four pole, shunt wound type.

(*b*) Ball bearings are fitted to the upper end of the shaft and needle roller bearings to the lower end.

(*c*) A driving pinion engages with the planet wheels of an epicyclic gear drive, which connects to the hydraulic generator.

(*d*) An oil seal is fitted between the electric motor and reduction gear to prevent oil from entering the motor.

(*e*) The electric motor speed is normally 3,000 revs. per minute, but by switching a resistance into the field circuit the motor speed is increased to 5,400 revs. per minute.

(*f*) The motor is screened and a suppressor fitted to prevent interference to the radio equipment.

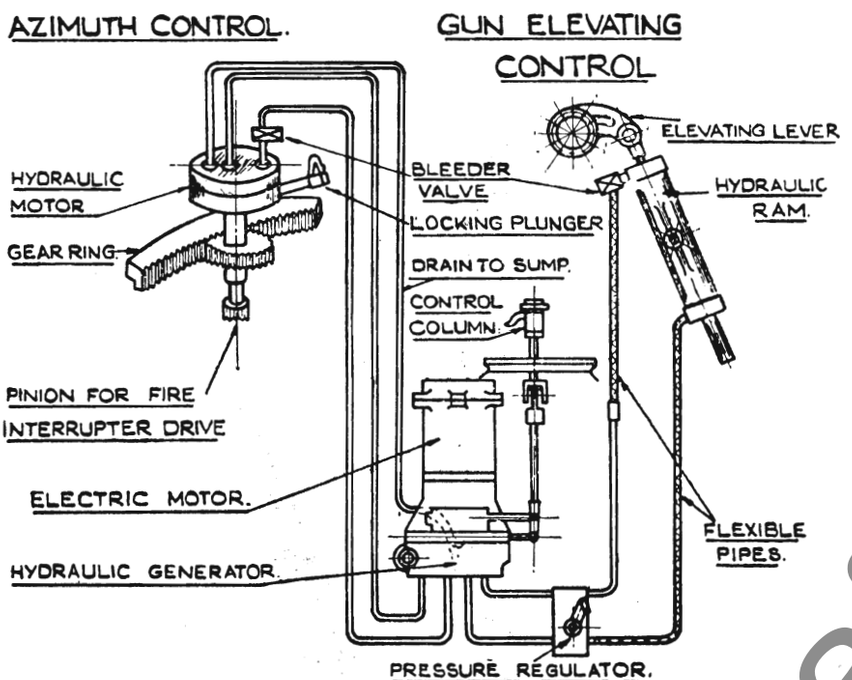
(*g*) The windings are protected against a short circuit by a fuse in the circuit.

http://www.2aircraft.net/

(*h*) The motor is controlled by two switches—

(i) The master switch.

(ii) The armature switch.

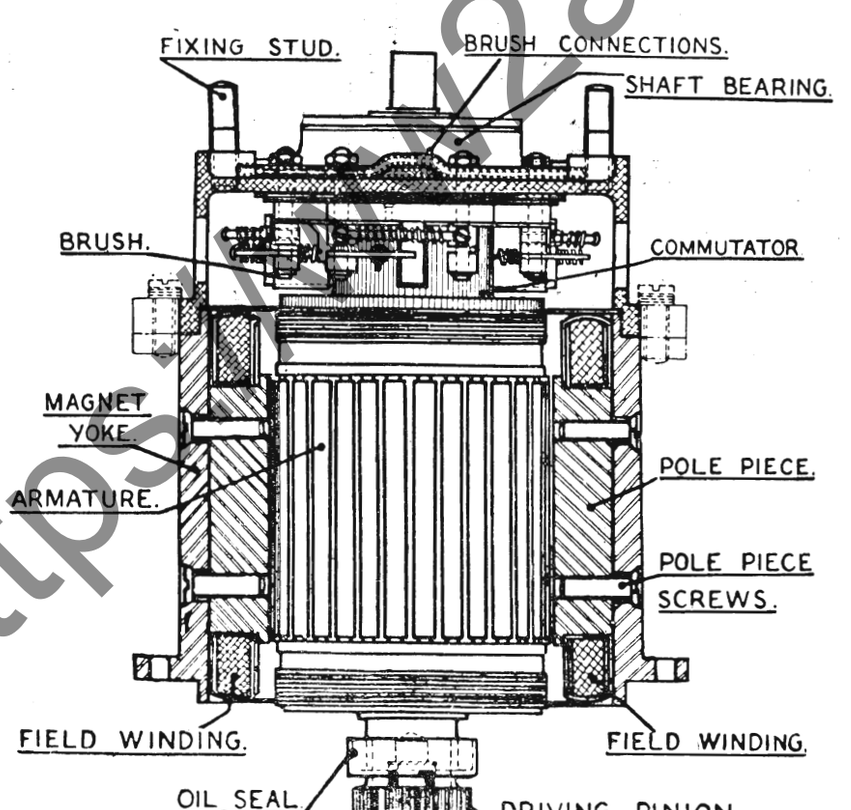


(*i*) The motor must be started at normal speed before the high speed switch is operated, otherwise there is a danger of the fuses blowing or the motor winding being damaged.

(*j*) Function of the electric motor and reduction gear—

(i) The hydraulic generator is driven by the electric motors, which are gauged together by an epicyclic gear drive, which reduces the electric motor speed to that required for the generator.

(ii) For quick traversing of the turret, the motor may be operated at high speed for a short duration only (15 secs. max.).



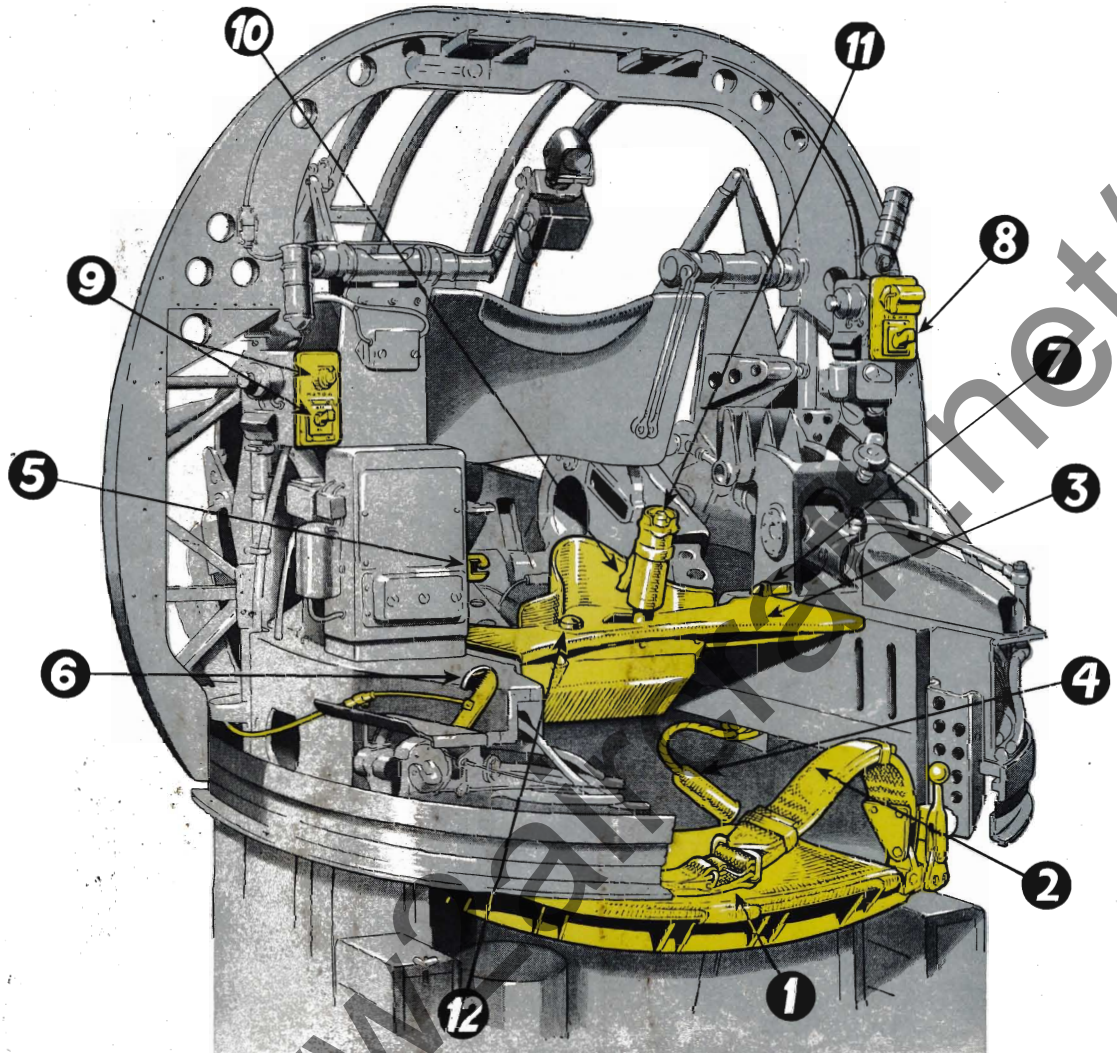
The Hydraulic Generator

4. (*a*) The generator consists of two separate pumps contained in the same housing.

(*b*) A single cylinder block embodies the two separate pumps, which are multi-plunger, reciprocating type.

(*c*) Each of the pumps is connected to a separate closed hydraulic circuit, one for rotation of the turret and the other for elevation and depression of the guns.

https://ww2aircraft.net/



A SEQUENCE OF OPERATIONS

1. SWIVEL SEAT TO WORKING POSITION
2. ATTACH SAFETY BELT
3. LOWER CONTROL TABLE AND LOCK WITH SLAM CATCH
4. INSERT INTERCOMMUNICATION PLUG IN SOCKET
5. PLUG IN TO OXYGEN SUPPLY
6. MOVE DISENGAGING GEAR LEVER TO ENGAGED POSITION
7. TURN MASTER SWITCH TO FIRE POSITION
8. SWITCH ON SIGHT SWITCH
9. SWITCH ON MAIN MOTOR SWITCH (RED WARNING LIGHT INDICATES MOTOR FIELD IS ENERGISED)

   NOTE.- DO NOT OPERATE CONTROL COLUMN UNTIL MAIN MOTOR SWITCH IS ON AND ARMATURE SWITCH LEVER IS GRIPPED
10. GRIP ARMATURE SWITCH LEVER ON CONTROL COLUMN TO START MOTOR AND OPERATE TURRET BY MOVING CONTROL COLUMN
11. DEPRESS FIRING BUTTON TO FIRE GUNS
12. FOR HIGH SPEED OPERATION DEPRESS HIGH SPEED BUTTON WHILE MOTOR IS RUNNING

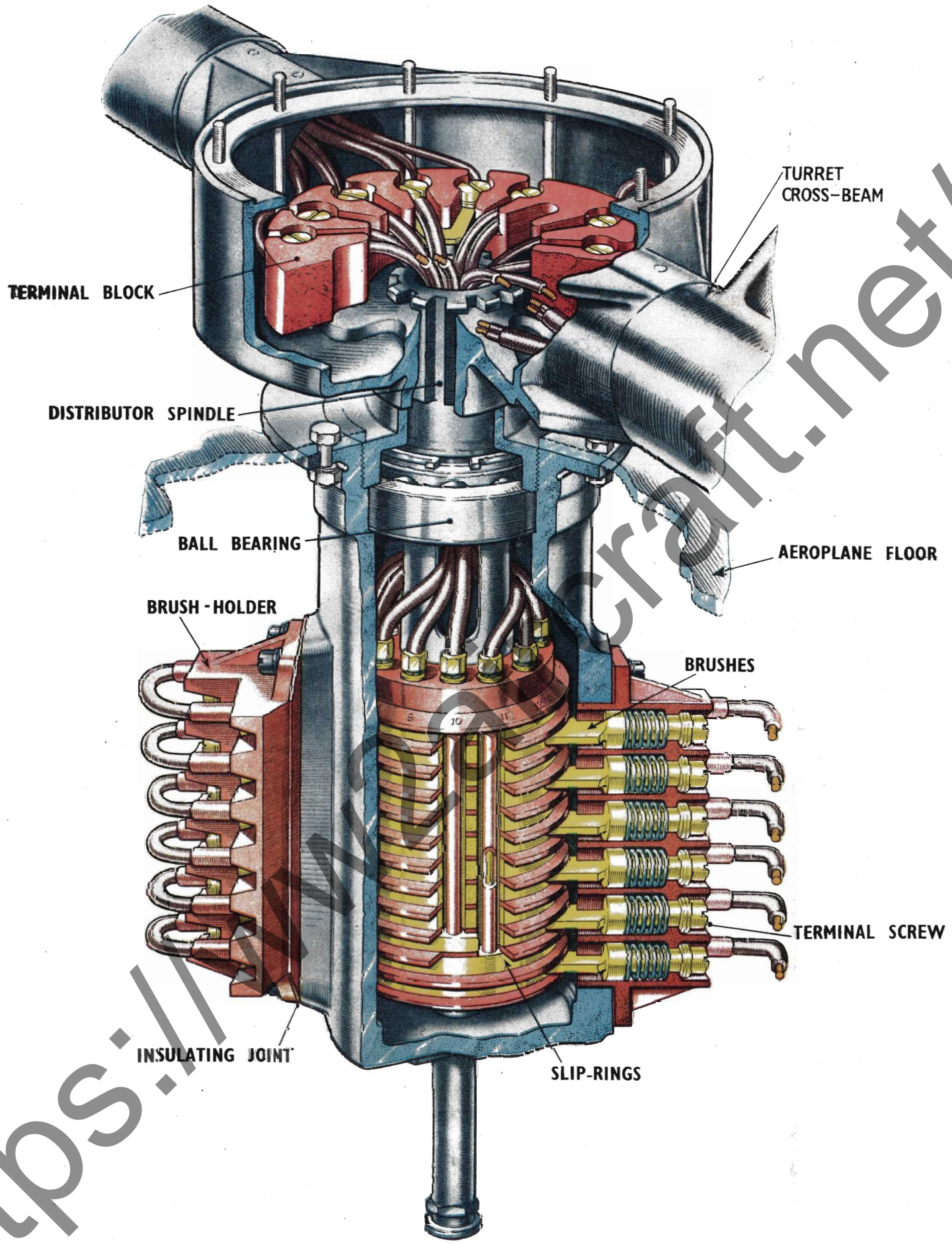
POWER OPERATION OF TURRET

For further information see A.P 1659 C, Vol I and Vol II

GUN TURRETS,

B.P., Type C, Mk. I, II, IIA, IV, and V

https://www.spitfire.net/

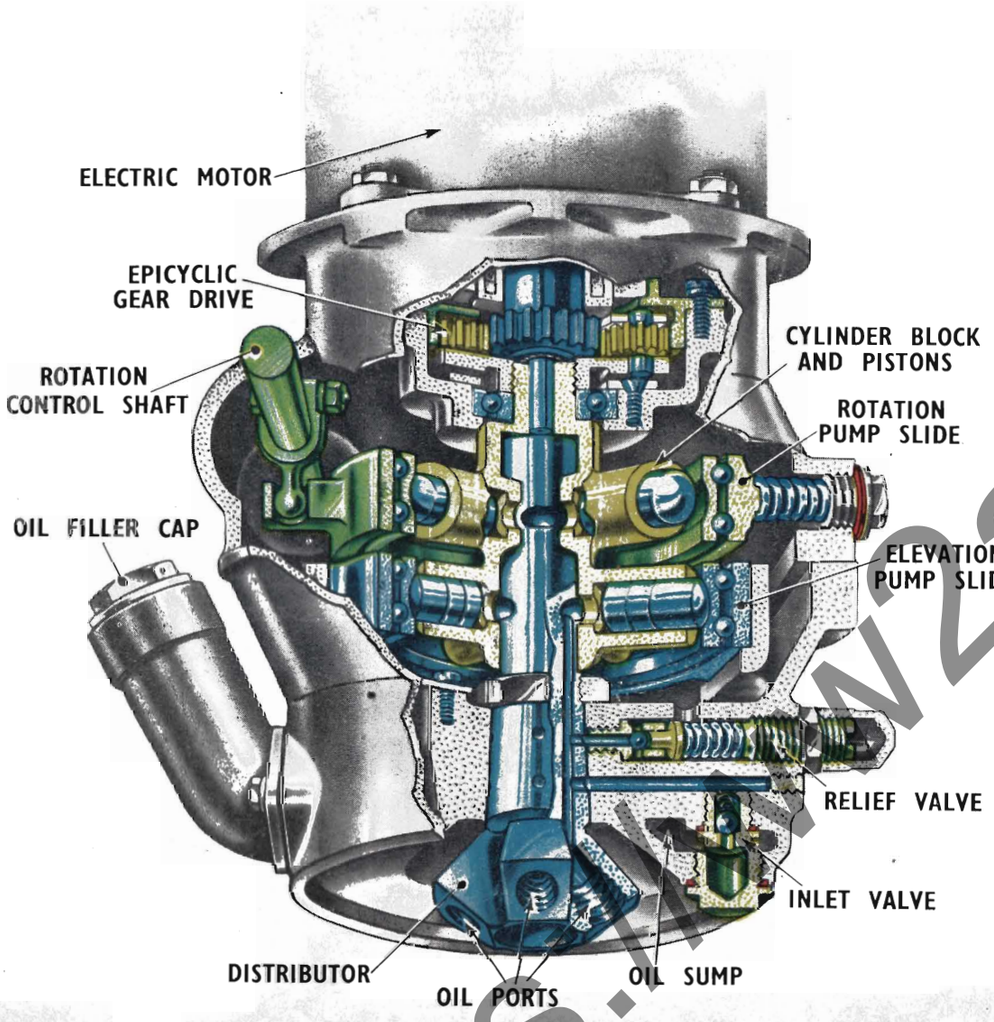


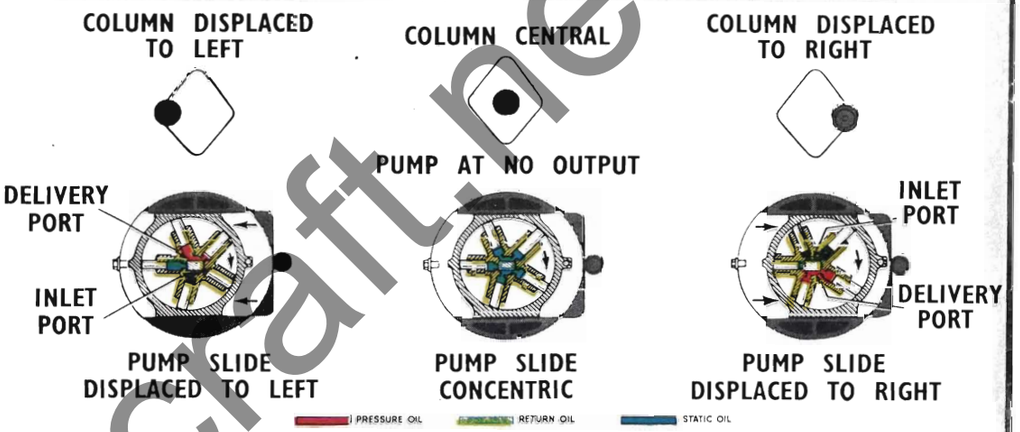
ELECTRICAL DISTRIBUTOR

GUN TURRETS,

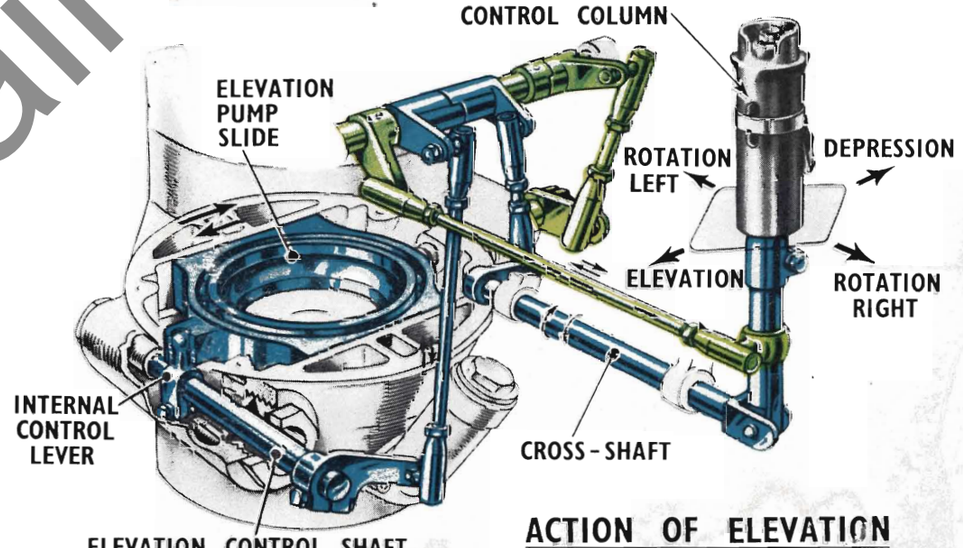
B.P., Type A, Mk. II D, and II R

https://www.aircraft.net/





ACTION OF ROTATION PUMP SLIDE



ACTION OF ELEVATION PUMP SLIDE

HYDRAULIC GENERATOR and CONTROLS

GUN TURRETS, B.P., Type C, Mk. I, II, IIA, IV, and V

https://www.2aircraft.net/

(*d*) Five pistons are fitted to each pump. The two pumps revolve together but the output of each is separately controlled by ball bearings slides which surround the outer ends of the pistons and can be displaced to eccentric positions on both sides. In their eccentric positions. stroke is imparted to the pistons as the cylinder block rotates, the amount of stroke and consequently the volumetric output depending solely on the displacement of the slides.

(*e*) The cylinder block consists of two radial banks of cylinders mounted on and rotating round a fixed shaft. This shaft acts as a distributor and is provided with four ports. Two ports in the distributor communicate with each bank of cylinders so that as the pump rotates, oil may be drawn in through one port and discharged through the other. The lower end of the distributor ports are connected by oil pipes to the rotation motor and elevating rams. When a reversal in the direction of oil flow is made, the delivery ports become the return ports and vice versa. The pistons are solid and have two sealing grooves cut in their skirts to prevent oil leaking past the pistons and to hold oil for lubricating the cylinder bores.

The pistons are made to rotate during their inward and outward strokes, so that wear is evenly distributed over the surfaces of the cylinder walls and pistons.

The two banks of cylinders operate in separate ball-bearing slides, both of which are connected to the control column by connecting arms and levers. The two slides are entirely independent of each other in operation, and provide independent control of the two pumps operating the rotation and elevation circuits.

The Control Column

5. (*a*) The slides are connected through a linkage to a stick type control column.

(*b*) The movement of the control column is limited by a diamond-shaped slot, which permits movement of the control column to give output of one pump or simultaneous output of both pumps.

(*c*) The lower portion of the hydraulic generator casing forms an oil sump in which is fitted a filler neck and drain plug.

The Relief Valves

6. (*a*) A spring loaded relief valve is fitted to each side of the two oil circuits, the four valves are connected by drilled oil-ways in the casing to the four ports in the distributor and set to blow-off when any excess pressure exists in the system.

(*b*) The blow-off pressure of the relief valves in the circuits is as follows:—

(i) Rotation—1,200 lbs. per sq. inch.

(ii) Elevation and Depression—750 lbs. per sq. inch.

(c) The relief valves operate under the following conditions:—

(i) Sustained operation of the control column in elevation or depression beyond the limit of movement of the elevating ram.

(ii) Sustained operation of the control column against the action of the interlock.

(iii) Blockage of the system.

Suction or Inlet Valves

7. The suction or inlet valve is a ball valve fitted into a valve body, four of which are screwed into the base of the generator casing and connect the oil sump with the pipe lines of the two circuits. These valves are gravity-loaded.

Functioning of the Hydraulic Generator and Components

8. (*a*) When the hydraulic pumps are rotated by the electric motor and reduction gearing the pistons in the pumps (which are not spring loaded) are thrown outwards (by the inertia of their own weight) against the inside of the ball bearing slides.

(*b*) If these slides are displaced to an eccentric position, stroke will be imparted to the pistons, so that the oil will be drawn through a port in the distributor and forced out the opposite port; thus pressure is built up in the circuit to operate the turret and guns.

(*c*) When the slides are displaced in the opposite direction, oil flow will be reversed in the rotation and elevating circuits.

(*d*) Should the pressure in either circuit become excessive, the relief valves will blow off.

(*e*) The inlet or suction valves are fitted to make up any deficiencies in the circuits, also to enable the oil from the sump to enter the circuits when initially filling the system.

The Hydraulic Rotation Motor and Reduction Gear

9. (*a*) The hydraulic motor is a reversible multi-plunger, cam type, radial motor. Some turrets are fitted with a six-cylinder motor, whilst others are fitted with a seven-cylinder motor; but both are identical in the method of construction and operation.

(*b*) The cylinder block is faced to rotate round a fixed distributor which is provided with inlet and outlet ports. The spindle of the cylinder block rotates on needle roller bearings.

(*c*) Two sealing grooves are cut in the skirt of each piston. Interposed between the rear end of the piston and the inside face of the supporting ring is a synthetic rubber piston ring and piston ring support for oil sealing.

(*d*) Two rollers are fitted to the end of the piston. On the outer ends of the cylinder are machined two flats. The piston rollers engaging on both sides of the flat, in conjunction with the rollers, bearing the elliptical cam face, prevent the piston from turning in the cylinder.

https://www.2aircraft.net/

(*e*) Reduction gear:—

(i) The main driving pinion is fitted in the turret table and engages with the annular fixed gear ring of the turret.

(ii) The two planet wheels mounted on the face of the driving pinions, engage with the pinion attached to the shaft of the hydraulic motor cylinder block.

(iii) An internally cut gear surrounds and meshes with the two planet wheels. The internally cut gear is capable of rotation but is normally locked by means of a plunger passing through the hydraulic motor support casting and engaging in one of the slots on the outside of the gear.

Functioning of the Hydraulic Rotation Motor and Reduction Gear (see diagram)

10. (*a*) The distributor spindle is drilled with oilways connecting the two pipe connections on top of the motor casing.

(*b*) These two pipes connect with two ports of the generator pump, which cause the turret's rotation.

(*c*) According to the direction of the rotation of the motor, one port serves as an inlet port and the other as an exhaust port.

(*d*) Oil from the generator is delivered under pressure to the inner ends of the pistons in the cylinders registering with the inlet port. These pistons are forced against, and maintained in contact with, the cam ring slope. The pistons travel down this slope causing the cylinder block to rotate.

(*e*) The power stroke is maintained over 90° of travel. During this movement, the cam form permits the pistons to move outwards. From the points where the cam form causes inward movement of the pistons the inlet port is cut off, and the cylinder then coincides with the exhaust port. The oil under the pistons is returned to the inlet side of the hydraulic generator by the inward movement of the pistons.

(*f*) This sequence of inlet and exhaust is continuous. The speed of the motor is controlled by the volumetric output of the generator.

(*g*) When a reversal in the direction of the turret rotation is required, the direction of the oil flow from the generator is reversed, so that the inlet ports in the rotation motor becomes the exhaust ports and vice versa. Thus the reversal of direction of rotation of the hydraulic rotation motor is achieved.

(*h*) When the cylinder block revolves, rotation is imparted to the turret, through the epicyclic reduction gearing, main driving pinion and fixed internal gear.

(*i*) Two pipe lines connect the hydraulic motor to the generator and so form the rotation circuit. A third pipe is fitted to the hydraulic motor to drain any surplus oil (that may leak past the pistons, distribution, etc.) back into the generator sump.

(*j*) The bleeder valve is fitted to one of the rotation circuit pipes at the top of the rotation motor, for the purpose of expelling air from the rotation circuit.

The Hydraulic Ram

11. (*a*) The ram is of the double acting type, having a cylinder of sufficient length to provide the necessary limits of stroke for elevation and depression of the guns.

(*b*) The piston is mounted half-way between the ends of the piston rod so that the rod extends through each end of the cylinder.

(*c*) The piston assembly is built on the fixed body of the piston and comprises two oil-resisting piston rings which are located on both sides of the fixed piston body.

(*d*) The piston rod passes through the ends of the cylinder. Oil resisting glands retained by springs located in the gland nuts provide an oil-tight seal. The gland assemblies forming the cylinder ends are adjusted on an assembling to provide the exact length of stroke required.

(*e*) The ram cylinder is pivoted centrally on needle bearings, which are fitted to the turret. The upper end of the piston rod is attached to the gun elevating lever by a gudgeon pin mounted in needle roller bearings. Attached to the lower end of the piston rod is the interlock mechanism.

Functioning of the Hydraulic Ram

12. (*a*) The guns are elevated or depressed by the hydraulic ram. The necessary power is supplied by the generator pump in the elevating circuit of the hydraulic system.

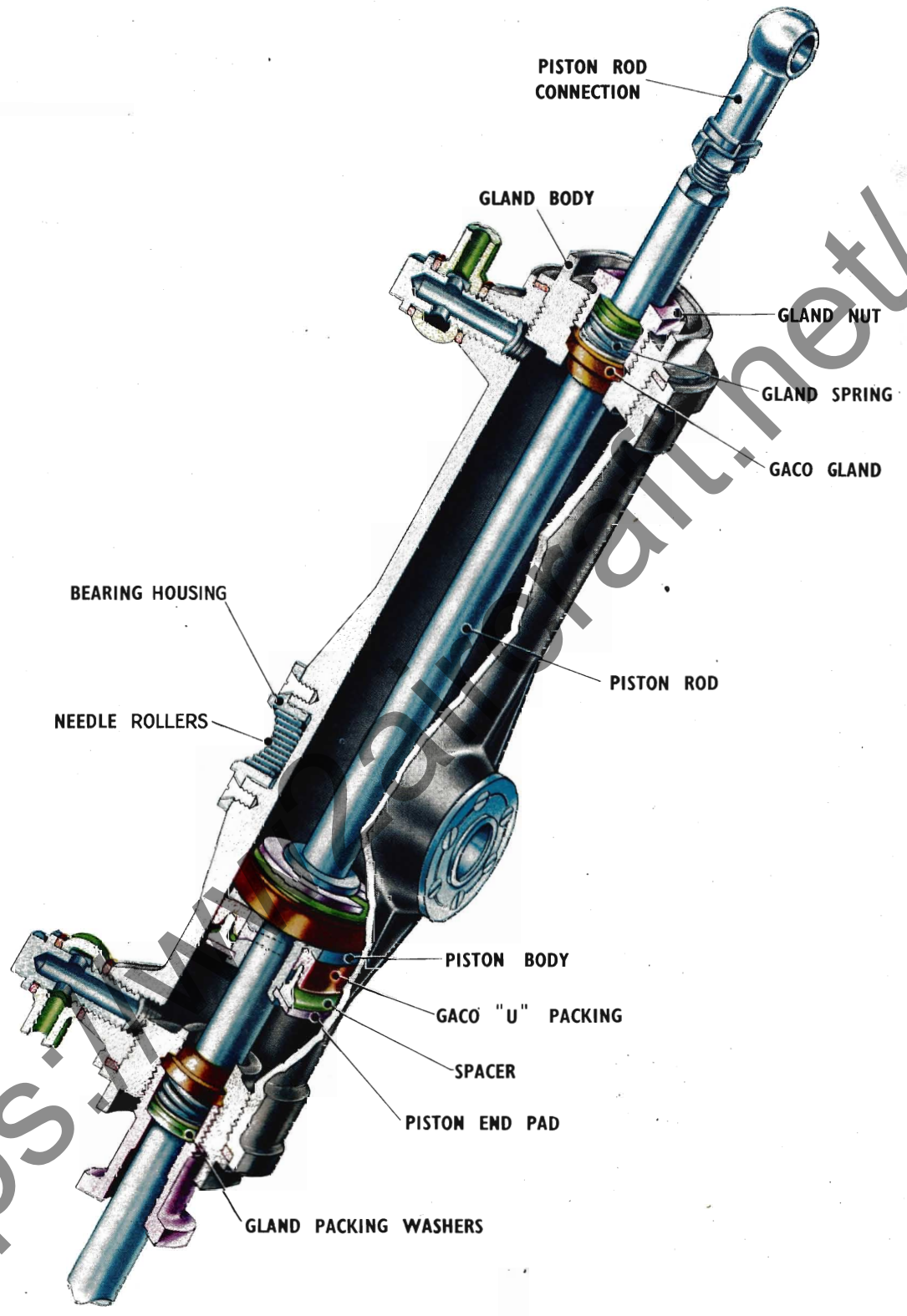
(*b*) Both ends of the ram are connected to the distributor of the hydraulic generator and provide either pressure or exhaust as required, on the sides of the ram.

(*c*) The interlock mechanism limits the movement of the guns to avoid fouling obstructions on the aeroplane.

(*d*) A bleeder valve is fitted to the hydraulic ram for expelling air from the elevating circuit.

(*e*) A pressure regulator is connected to the main circuit to provide a damping resistance throughout both elevation and depression.

https://www.2aircraft.net/



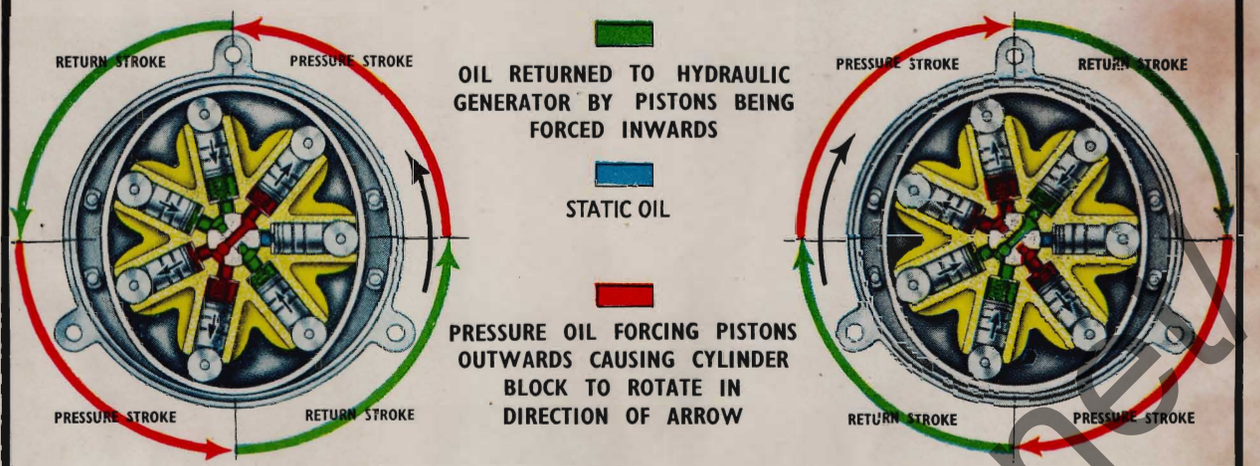
GUN ELEVATION RAM

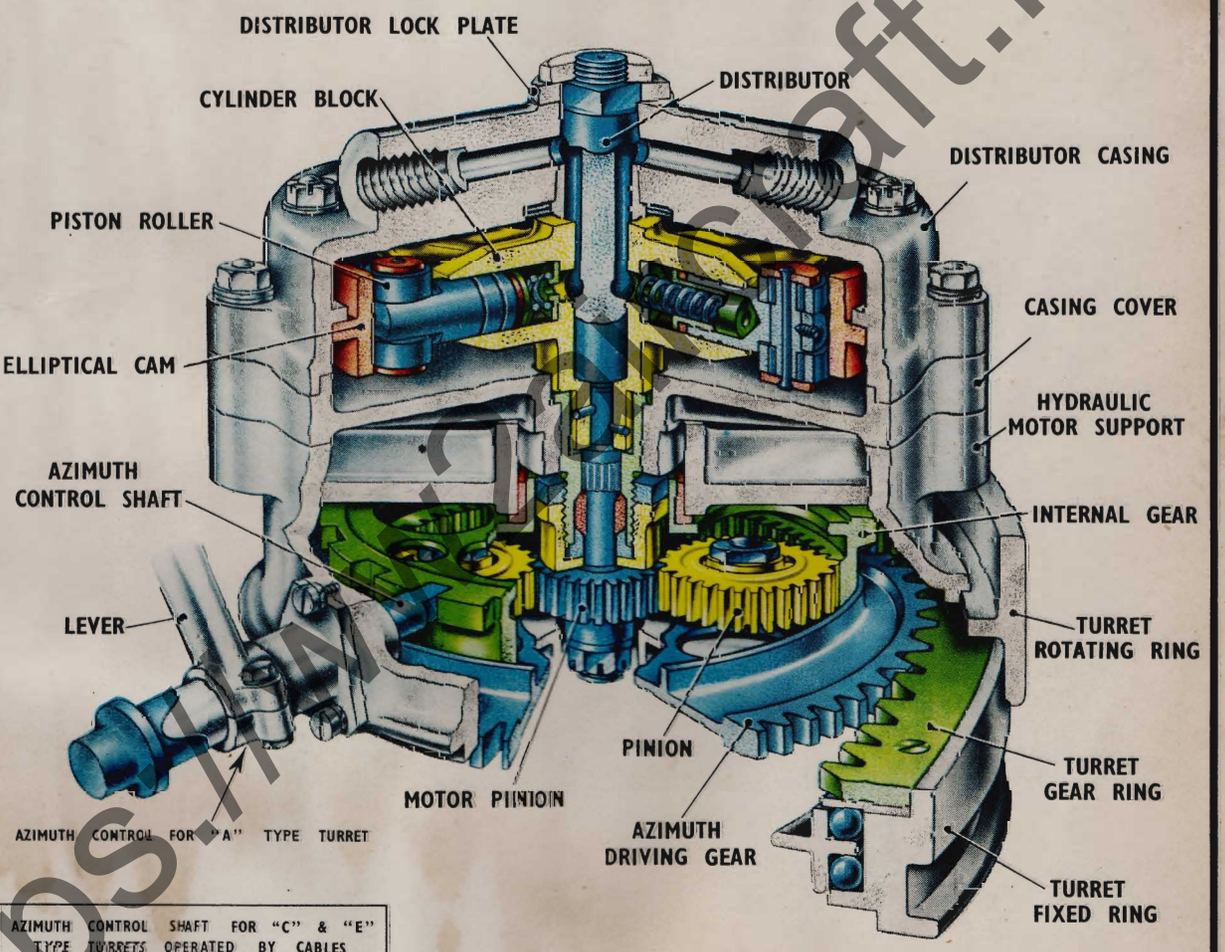
GUN TURRETS,

B.P., Types A and C

For further information see A.P. 1659 C. Vol. I and Vol. II

https://www.ajbpratt.net/





HYDRAULIC MOTOR AND REDUCTION GEAR

GUN TURRETS, B.P., Types A, C, and E

For further information see A.P. 1659 C. Vol. I and Vol. II

https://ww2aircraft.net/

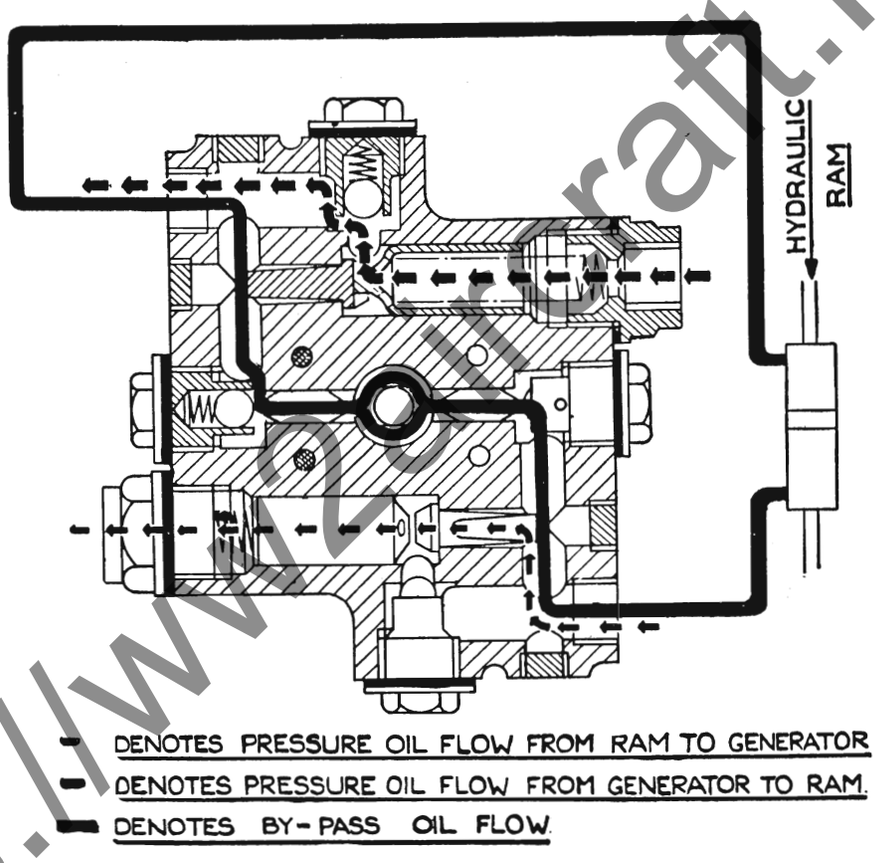
The Pressure Regulator and By-Pass Valve

13. (*a*) The pressure regulator is attached to the turret frame and is connected to both pipes from the generator to the hydraulic ram.

(*b*) The two passages of the regulator through which oil is fed into each end of the ram are equipped with identical sets of valves.

(*c*) Each set of valves consists of a lightly loaded non-return ball valve, past which oil is normally fed to the ram, and a spring-loaded metering valve, operating in the opposite direction. The oil returning from the ram to the generator opens the metering valve which operates against the pressure of its spring.

(*d*) The by-pass passage drilled through the centre of the pressure regulator connects the valves to the ram ends. The by-pass valve consists of two spring-loaded ball valves operated by stalks or rods from a central cam. Attached to this cam is a shaft which passes through the casing and connects with the free and engaged lever. A packing gland is provided to prevent oil leakage past the shaft, even though there is no pressure on this gland during normal functioning of the turret as the ball valves shut off this portion of the component from the main hydraulic system.


HYDRAULIC RAM
DENOTES PRESSURE OIL FLOW FROM RAM TO GENERATOR
DENOTES PRESSURE OIL FLOW FROM GENERATOR TO RAM.
DENOTES BY-PASS OIL FLOW.

Functioning of the Pressure Regulator and By-Pass Valve

14. (*a*) Oil entering the ram from the generator passes through the lightly loaded ball valve in one passage, whereas oil expelled from the ram passes through the spring loaded metering valve in the other passage.

(*b*) The metering valve only opens the required amount to pass the quantity of oil being returned from the exhaust side of the ram: thus the return oil is maintained at a pressure of approximately 130 lbs. per sq. inch.

(*c*) With the guns stationary, the lightly loaded ball valve delivering oil to the ram closes; the metering valve closes when the pressure of the return oil is below 130 lbs. per sq. inch; thus with both valves closed a hydraulic lock is obtained.

(*d*) When the "free and engaged lever" has been moved to the "FREE" position, the cam rotates through 90° and so reaches its horizontal position. The by-pass valve stalks are forced outwards, opening the ball valves to provide a passage for the oil from one end of the ram, through the by-pass passages, to the opposite end of the ram, so breaking the hydraulic lock and making it possible to elevate and depress the guns manually.

https://www.2ndraft.net/

Disengaging Gear ("Free and Engaged Lever")

15. (*a*) This enables both rotation and elevation to be freed from the hydraulic system.

(*b*) It also operates a switch in the gun firing circuit.

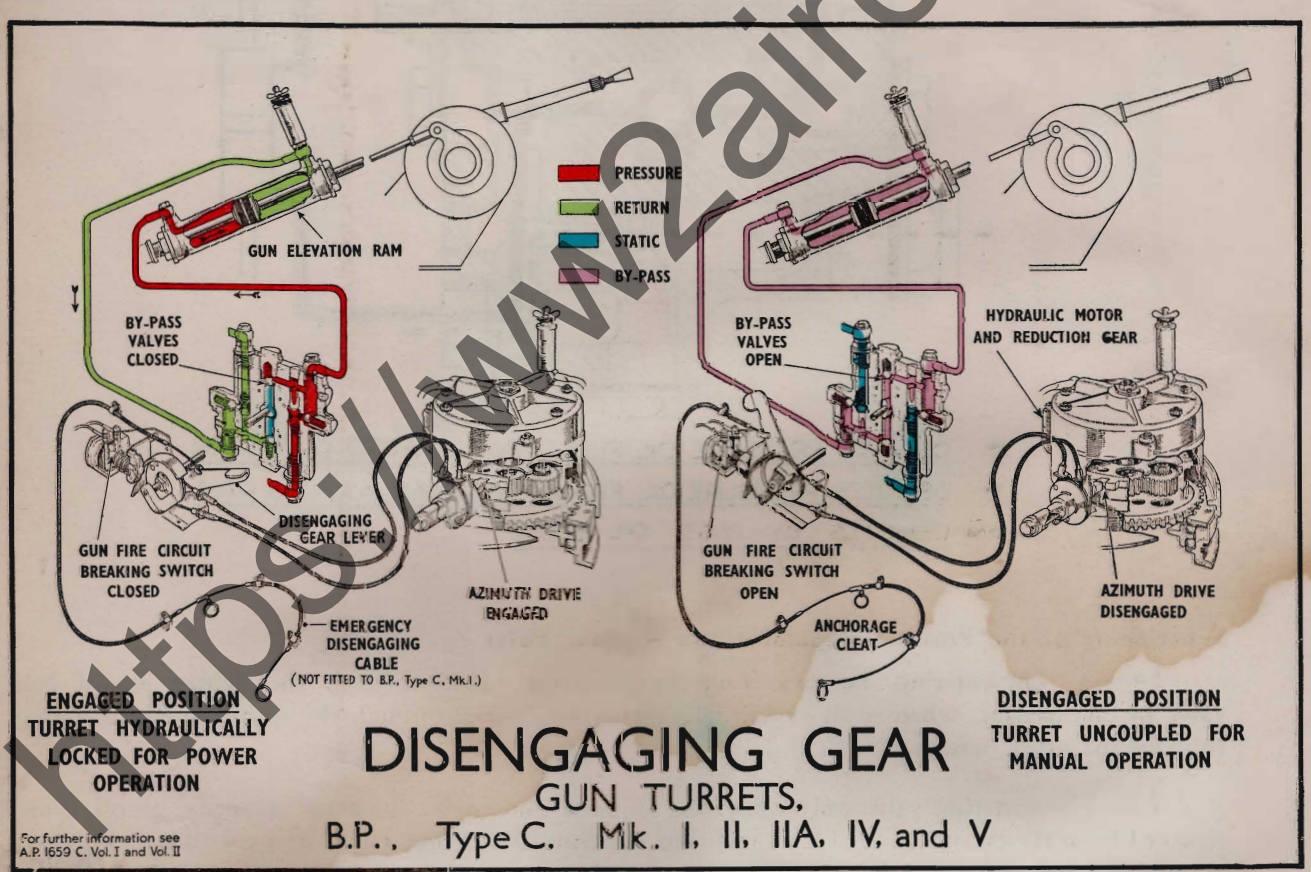
(*c*) The mechanism is so constructed that movement of the lever affects the three components simultaneously as follows:—

(i) The lever is mounted on the by-pass valve cam shaft. When the lever is in the "ENGAGED" position, the by-pass valve in the ram circuit is closed, and the guns are hydraulically locked in elevation and depression. When placed to the "FREE" position, the by-pass valve in the ram circuit is opened, thus by-passing the oil, so that the guns can be depressed or elevated manually.

(ii) The lever is connected to the control cam operating the control shaft on the disengaging gear by flexible cables, which pass round and are anchored to a pulley attached to the "FREE and ENGAGED" lever. The control shaft lever passes through the reduction gear casing, to engage with one of the castellations on the periphery of the internally cut gear housing of the hydraulic motor reduction 'gearing. When the lever is in the "ENGAGED" position this gear is locked. The hydraulic motor, being coupled to the stationary ring, rotates the turret. When the lever is in the "FREE" position the plunger is withdrawn and the gear is free to rotate. As the hydraulic motor is disengaged from the stationary ring, the turret can be rotated manually.

(iii) A press button switch is connected in the firing circuit, and is operated by a cam on the lever hub. A thin metal plate is provided between the cam and the press button to prevent wear. When the lever is in the "ENGAGED" position, the switch operating cam depresses the switch button. The switch is "On" and firing is possible. With the lever in the "FREE" position, the switch operating cam is clear of the switch and firing of the guns electrically, prevented.

NOTE.—A modification has been incorporated in Boulton Paul turrets on Hudson A/C to enable the disengaging gear to be operated by a Bowden cable from outside the turret in the event of the air gunner becoming a casualty.



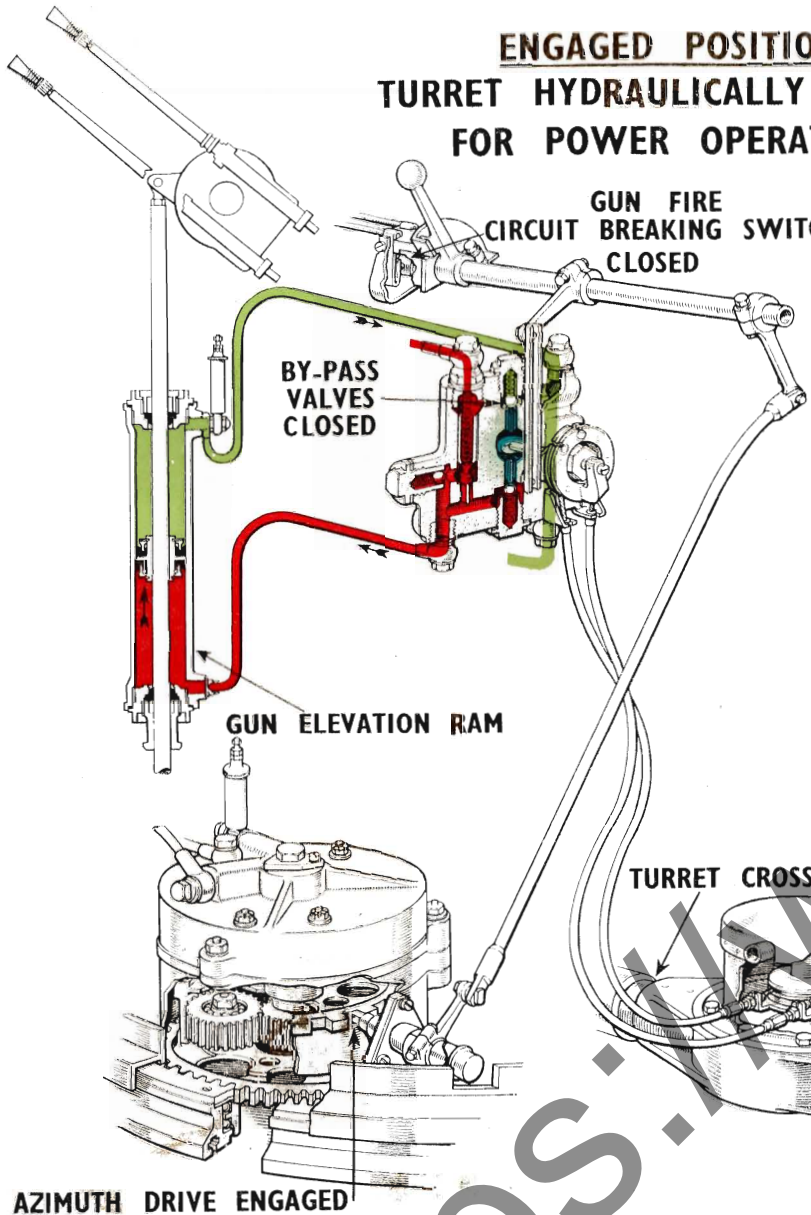
Stirrup or Claw Type Interlock Mechanism

16. (*a*) Depending on the type of turret, either a stirrup or claw type interlock mechanism is fitted to the lower end of the hydraulic ram.

(*b*) A bell crank lever and roller engaging a cam on the fixed ring of the turret, operate a flexible cable which engages the claw interlock with a stop collar fitted on the ram piston rod. In the case of the stirrup type the flexible cable moves a stirrup under the end of the piston rod. In both types the guns are prevented from damaging the fuselage by limiting the depression of the guns whilst the guns are passing over the fuselage.

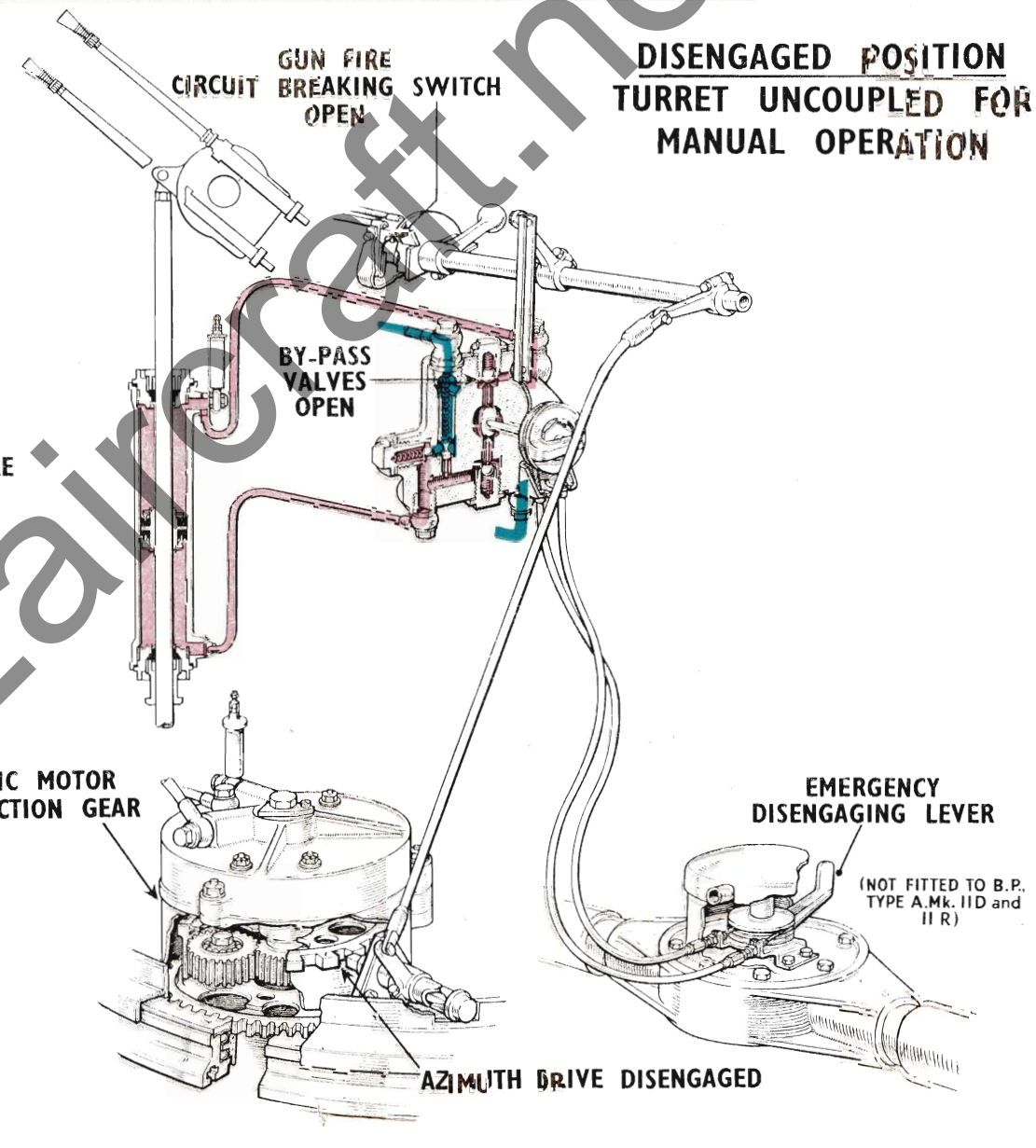
https://www.2aircraft.net/

ENGAGED POSITION
TURRET HYDRAULICALLY LOCKED FOR POWER OPERATION



PRESSURE
RETURN
STATIC
BY-PASS

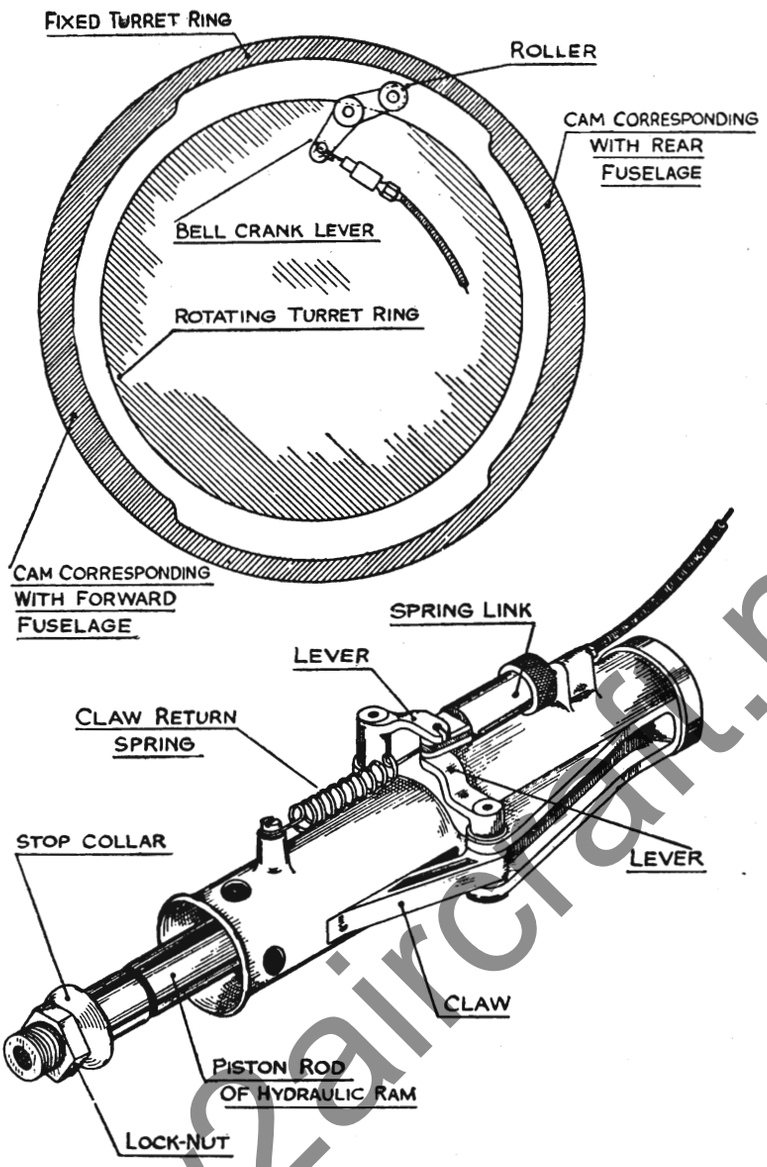
DISENGAGED POSITION
TURRET UNCOUPLED FOR MANUAL OPERATION


GUN FIRE CIRCUIT BREAKING SWITCH OPEN
BY-PASS VALVES OPEN
HYDRAULIC MOTOR AND REDUCTION GEAR
EMERGENCY DISENGAGING LEVER
(NOT FITTED TO B.P. TYPE A.Mk. IID and IIR)
AZIMUTH DRIVE DISENGAGED

DISENGAGING GEAR
GUN TURRETS,
B.P., Type A, Mk. IID, IIR, III, IV, V, VA, and VI

For further information see A.P. 1659 C. Vol. I and Vol. II

https://www.2aircraft.net/



Interlock Plunger Stop Mechanism

17. (*a*) On the Hudson centre gun turret this device consists of a cam fitted to the gun arm shaft which corresponds to the angle of depression of the guns below the fuselage. The cam operates a roller and bell crank lever, which, through a linkage extends a bolt plunger into the space between the fixed and rotating rings of the turret. Stops are provided on the fixed ring to engage with the bolt plunger, when the turret is rotated towards the fore and aft fuselage with the gun depressed. Further rotation will be prevented until the guns are elevated to a safe level above the fuselage.

(*b*) On the Roc 1 and the Defiant 1 centre gun turrets the bolt plunger is operated by a striker sleeve rod and lever. A step on the ram piston engages the striker sleeve, and by means of the rod and lever, extends the bolt plunger, so that if the turret is rotated while the guns are depressed, the plunger will engage the stops on the fixed ring, and prevent further rotations until the guns are elevated to a safe level above the fuselage.

Hand Rotation Gear

18. (*a*) This consists of a crank lever, bevel gearing, shaft and a gear wheel engaging with the turret gear ring.

(*b*) The hand rotating gear is used to rotate the turret manually when the "FREE and ENGAGED" lever is in the "FREE" position, and the guns are elevated sufficiently to clear the interlock stops on the turret ring.

(*c*) Any attempt to turn the gear against the hydraulic lock when the "FREE and ENGAGED" lever is in the "ENGAGED" position, or when the interlock is engaged, may strain the mechanism.

Gun Fire Interrupter

19. (*a*) The gun fire interrupter protects portions of the aeroplane (which interfere with the field of fire) from possible damage by the guns.

(*b*) The interrupter is interposed in the firing circuit and is therefore only effective when the guns are fired electrically. For this reason the guns must always be fired electrically, otherwise the purpose of the interrupter is defeated.

(*c*) The interrupter device consists of a brass drum driven by a train of gears on a chain and sprocket from the hydraulic rotation motor.

http://www.2aircraft.net/

(i) The drum rotates at the same speed as the turret.

(ii) Areas on the drum are insulated to correspond to areas of the field of fire obstructed by parts of the aeroplane.

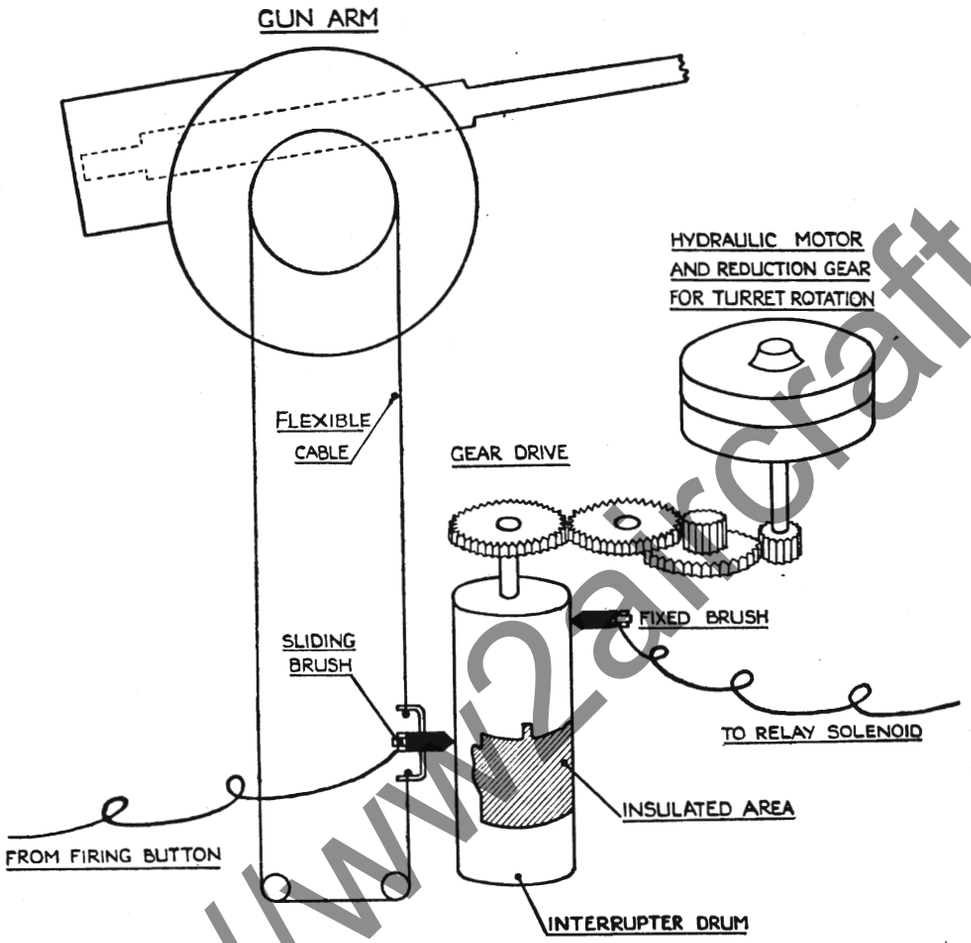
(iii) A fixed brush is in contact with the drum, and is connected by wiring to the gun firing switch.

(*d*) A sliding brush moving on vertical guide rods is controlled by a cable passing around a groove in the gun arm shaft, then over guide pulleys and terminating at each side of the sliding brush arms.

(i) The sliding brush movement corresponds with the elevation and depression of the guns. The sliding brush is connected by wiring to the relay solenoid for each pair of guns.

(ii) In a four-gun turret, two sliding brushes are fitted, one brush serving each pair of guns.

(*e*) The brushes consist of a spring-loaded plunger with a small steel ball secured to its contact end, to ensure a point contact with the drum surface.



Functioning of the Gun Fire Interrupter

20. (*a*) The rotation of the interrupter drum and the brush movement along the drum are synchronised, with both the turret rotation and the elevation and depression of the guns, thus causing the area on the drum surface to correspond with the area of the gun fire.

(*b*) When the line of fire of the guns approaches interfering portions of the aeroplane, the sliding brush is moved on to an insulated part of the drum surface, breaking the gun-firing circuit, and so interrupting firing during the period when the brushes are in contact with the insulated area of the drum.

The Electrical System

21. The electrical system consists of separate circuits.

(*a*) The power circuit.

(*b*) The turret and sight illumination circuit.

(*c*) The gun firing circuit.

The Turret Assembly

22. (*a*) The turret is a self-contained circular structure carried on a metal ring rotating on ball bearings in a ring fixed to the aeroplane by 12 bolts.

(*b*) The turret with the guns, ammunition, power system, etc., rotates for azimuth training.

(*c*) A domed cupola of transparent material is provided to protect the air gunner from the slip stream.

(*d*) The gun barrels project through vertical slots in the cupola, which allow for the elevation and depression of guns. These slots are sealed by shutters or plate against the air stream in all positions of the guns.

https://ww2aircraft.net/

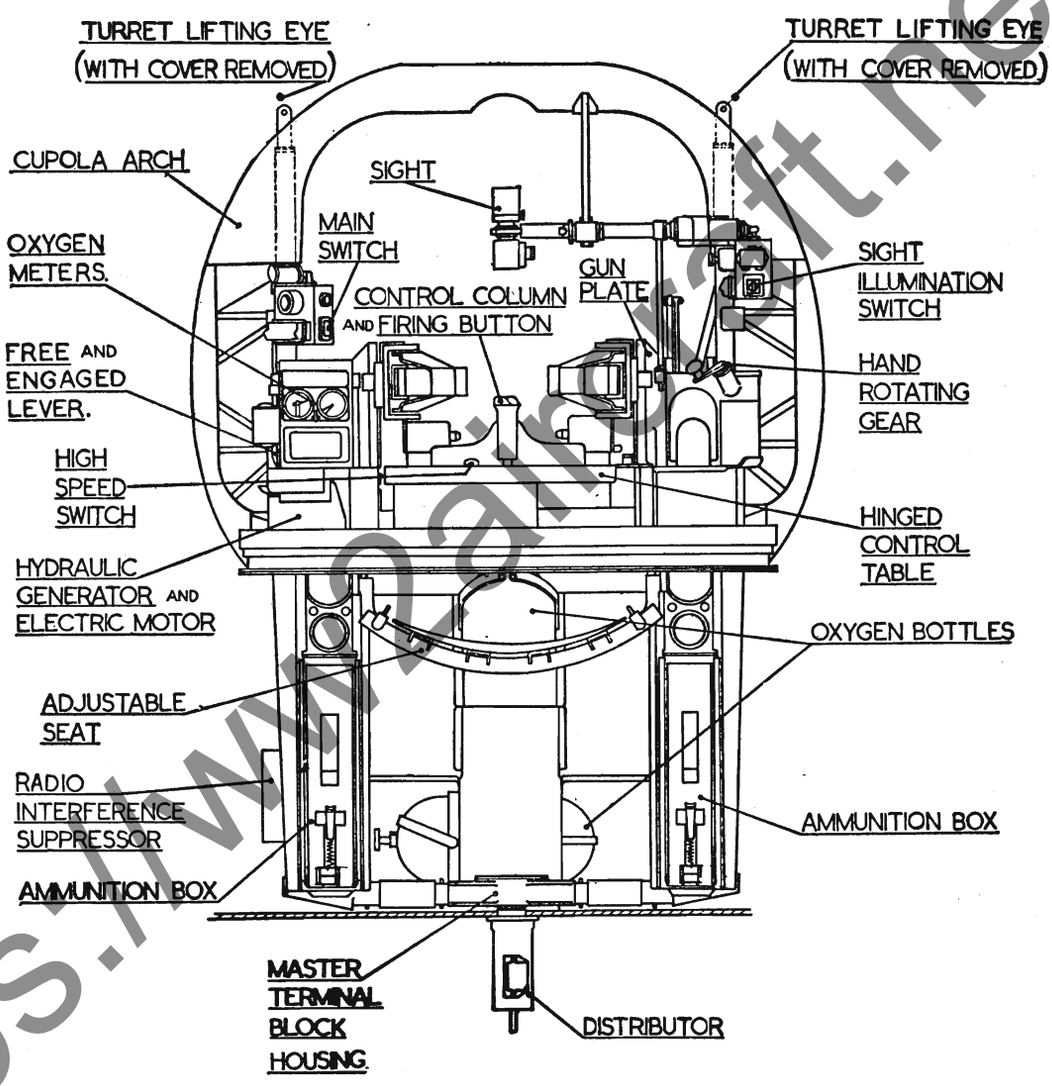
(*e*) Turret lifting eyes are fitted to the top of the cupola for lifting the complete turret in and out of the aeroplane.

(*f*) In the Hudson centre gun turret, entrance to and exit from the turret are only possible through the underside of the turret.

(*g*) The Roc 1 (and Defiant 1) turret cupola is fitted with sliding doors for entrance to and exit from the turret, when the aeroplane is on the ground. When it is in the air the sliding doors may be opened, or the emergency hatchway in the fuselage behind the turret may be used, as an emergency exit.

(*h*) Contained within the turret other than the components previously mentioned, are the air gunner's seat, ammunition boxes, chutes and feed rollers, empty cartridge case containers and shells, oxygen system, control panel, switches, lights, intercommunication system, gun plates, gun mountings, gunsight and the electrical gun firing mechanism.

(*i*) The oxygen system fitted to the turret has two 750-litre bottles containing the supply of oxygen.



The Electrical Gun Firing Mechanism

23. (*a*) The Boulton Paul gun firing control is entirely electrical, depending for its power on the normal electrical supply of the aeroplane.

(*b*) At present, only rear sear release electrically operated units for Browning guns are being produced and it is necessary to fit the guns with hand operated "FIRE and SAFE" units.

(*c*) Any number of Browning guns can be controlled, provided there is sufficient electrical energy available in the batteries.

(*d*) The guns are fired by firing solenoids which are connected in parallel. As each solenoid requires a correct current of 5 amps., relay solenoid switches are included in the circuit, one for each pair of guns.

(*e*) The purpose of the relay switches is to relieve the air gunner's firing switch of the heavy current which would be required for direct operation of the firing solenoids.

https://www.2aircraft.net/

(*f*) Each solenoid switch requires a current of approximately 1·4 amps., so that the load on the firing switch in a four-gun installation will be no more than 2·8 amps.

(*g*) The circuit is completed through the medium of a master switch and by pressing the firing switch situated in the turret contact column.

(*h*) In the Hudson turret the master switch is marked "SAFE and FIRE."

(*i*) In the Roc and Defiant turrets, the master switch is of the three-way type, and is marked "PILOT, OFF, and GUNNER," which enables the firing control to be transferred to the pilot. A firing button is mounted in the aeroplane control column for this purpose.

(*j*) Included in the circuit is a circuit breaking switch which is operated by the "DISENGAGING GEAR LEVER" of the turret and prevents the gun from being fired when the turret is not hydraulically locked.

(*k*) Two types of gun firing interrupters are used:—

(i) A single brush type for turrets where the guns are mounted so close together that separate interruption is unnecessary. The turret fitted to Hudson A/C is a typical example of the single brush interrupter.

(ii) A dual type for separate interruption when guns are mounted some distance apart, as on the Roc and Defiant turrets.

(*l*) Two types of gun firing solenoids are used:—

(i) When the firing solenoids are mounted on the guns. (Roc and Defiant.)

(ii) When the firing solenaids are mounted remote from the guns and fire the guns through the medium of flexible cables.

Functioning of the Electrical Gun Firing Mechanism

24. (*a*) When the master switch is turned to "GUNNER" (Roc and Defiant, turrets) or to "FIRE" (Hudson, turret), and the firing button on its contact column depressed, the circuit is completed, energising the solenoid switch, which closes the contacts and completes the circuit to the gun firing solenoids.

(*b*) The coils of the gun firing solenoids are energising, drawing the plunger and spindle downwards.

(*c*) The end of the spindle is attached to a lever and tappet, which operate the sear lever and so fire the gun.

(*d*) Immediately the firing switch is released, the magnetic field of the firing solenoid collapses and the spring loading on the rear sear returns the tappet, lever and cable to their normal position.

NOTE.—For complete description of construction and functioning, refer to A.P. 1641E, Vol. I, Part 2, Chapter 1, "Aircraft machine gun firing control mechanisms."

FILLING AND BLEEDING AND TOPPING UP THE SYSTEM

25. (*a*) To fill an empty turret system approximately 6 pints of oil lubricating, anti-freezing type "A" (Stores Reference 34A/43 or 46) is required.

(*b*) The greatest possible care should be taken to ensure that the oil is filtered and properly clean, as dirty oil will be injurious to the hydraulic components.

(*c*) Filling. The method of filling the system is as follows:—

(i) Remove the filter cap from the filler neck in the generator body and set the "FREE AND ENGAGED LEVER" to the "FREE" position.

(ii) Fill the generator sump with oil.

(iii) Turn on the motor switch and grip the armature switch lever on the control column.

(iv) The pumps on the generator are now running and the rotational circuit is filled by moving the control column to the right or left.

(v) When the control column is displaced from its central position it will be observed that the oil level in the sump gradually falls. This oil level should be continually topped up until the rotational circuit is filled. Do not remove the gauze filter in the filler neck, when adding oil.

(vi) To fill the elevating circuit, depress the guns to their fullest extent, set the "FREE AND ENGAGED LEVER" to the "ENGAGED" position. Move the control column to its rear position to elevate the guns and at the same time top up the oil level in the generator.

Bleeding Air from the Rotational Circuit

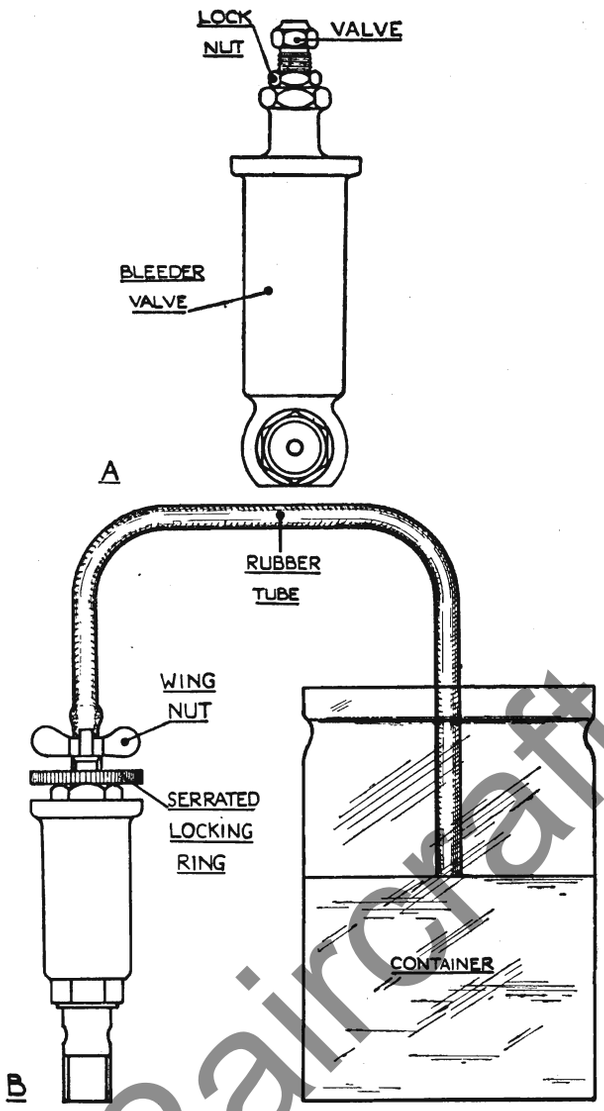
26. (*a*) On turrets fitted with an external pressure filter. Slacken off the screw in the top of filter cap. Operate the turret by power. An emulsion, consisting of air and oil, will be expelled. Continue until all the air has been cleared. Then securely tighten the screw.

(*b*) When the bleeder valve is fitted on top of the hydraulic motor casing, bleed the circuit as follows:—

(i) Attach one end of a rubber tube to the ball-shaped end of the valve. Slacken off the serrated locking ring and wing nut on top of the valve stem.

(ii) Operate the turret by power and expel all the emulsion of air and oil through the tube into a suitable container. After bleeding, tighten valve wing nut and locking ring, remove rubber tube and top up the oil level in the sump.

https://ww2aircraft.net/



Bleeding Air from the Elevating Circuit

27. (*a*) Alternative types of bleeder valves are fitted to the hydraulic ram. Although different in design the principle of operation is very similar, but external filters may be fitted in the elevating circuit. Bleed the circuit as follows:—

(i) Open bleeder valve or filter bleeder screw.

(ii) Operate the turret by power until all emulsion of air and oil has been expelled into a suitable container.

(iii) Tighten bleeder valve or bleeder screw, top up oil level in sump.

Draining the Hydraulic System

28. (*a*) To drain the oil from the hydraulic system, remove the drain plug on the underside of the sump.

(*b*) Disconnect the four pipes attached to the generator distributor in the centre of the sump base.

(*c*) After draining the oil into a suitable container, replace drain plug, connect pipes to the distributor and renew the locking wire of the banjo stalks of the pipes.

NOTE.—In certain turrets external pressure filters are incorporated as an additional precaution against dirt circulating in the hydraulic system.

OPERATION OF THE TURRET

29. (*a*) Before entering the turret open the valve of the lower oxygen bottle, as this operation is difficult when the gunner is seated.

(*b*) After entering the turret release the seat locking lever, thus allowing the seat to fall into its normal horizontal position and to engage the spring lock.

(*c*) In the Hudson turret, lower the control table and lock it in position with the slam catch. Attach safety belt. Connect intercommunication plug with socket.

(*d*) Ensure that the "FREE AND ENGAGED LEVER" is in the "ENGAGED" position.

(*e*) Turn "SAFE AND FIRE" switch to "FIRE" or "Gunner."

(*f*) Switch on sight switch (if sight is required).

(*g*) Switch on the main motor switch. (On the Roc or Defiant turret turn the retracting fairing lever to the left: "Fairings Down Position," then turn on the motor switch. The motor field only is then energized and a warning lamp indicates that the switch is on.)

https://ww2aircraft.net/

GUN INSTALLATION

32. (*a*) Two-gun Turret (Hudson).

(i) Two guns Browning ·303 inch are mounted on their sides; the guns are 10 inches apart and on the same level.

(ii) Each gun is attached by a bolt to the front mounting which consists of a sliding trunnion, spring-loaded at both ends; the shock of recoil and reaction is absorbed by the springs.

(iii) The rear mounting bracket of the gun is bolted to the rear mounting fork which is attached to a vee-slide in the gun-plate and provides adjustment for the gun both in azimuth and elevation.

(iv) Gun guards are fitted to the end of the gun plates to protect the air gunner's knees from possible injury by the recoiling guns.

(v) The firing solenoids are mounted on the gun plates below the guns. A flexible cable from the gun firing lever is connected to the gun firing lever mechanism. The firing lever bears against the tappet on the trigger plate of the gun.

(vi) The guns are fitted with suitable link, feed and empty cartridge case chutes and also a blast tube adaption.

(vii) The blast tube is fitted with a shutter sleeve which when opened allows air to pass around the part of the barrel inside the turret, and assists in ventilating the turret. The shutter sleeve can be shut when necessary.

(*b*) Four-gun turret (Roc and Defiant).

(i) Four Browning ·303-inch machine guns are mounted in pairs on both sides of the turret. Each gun is mounted on two fixed trunnion mountings attached to the face of the gun plate (the horizontal distance between the barrel centres is 28·44 inches and the vertical distance is 6·46 inches).

(ii) The rear trunnion mountings are adjustable for azimuth elevation and depression.

(iii) The front mountings are designed to accommodate any movement due to adjustment.

(iv) The gun mountings are not spring-loaded and therefore do not require gun guards.

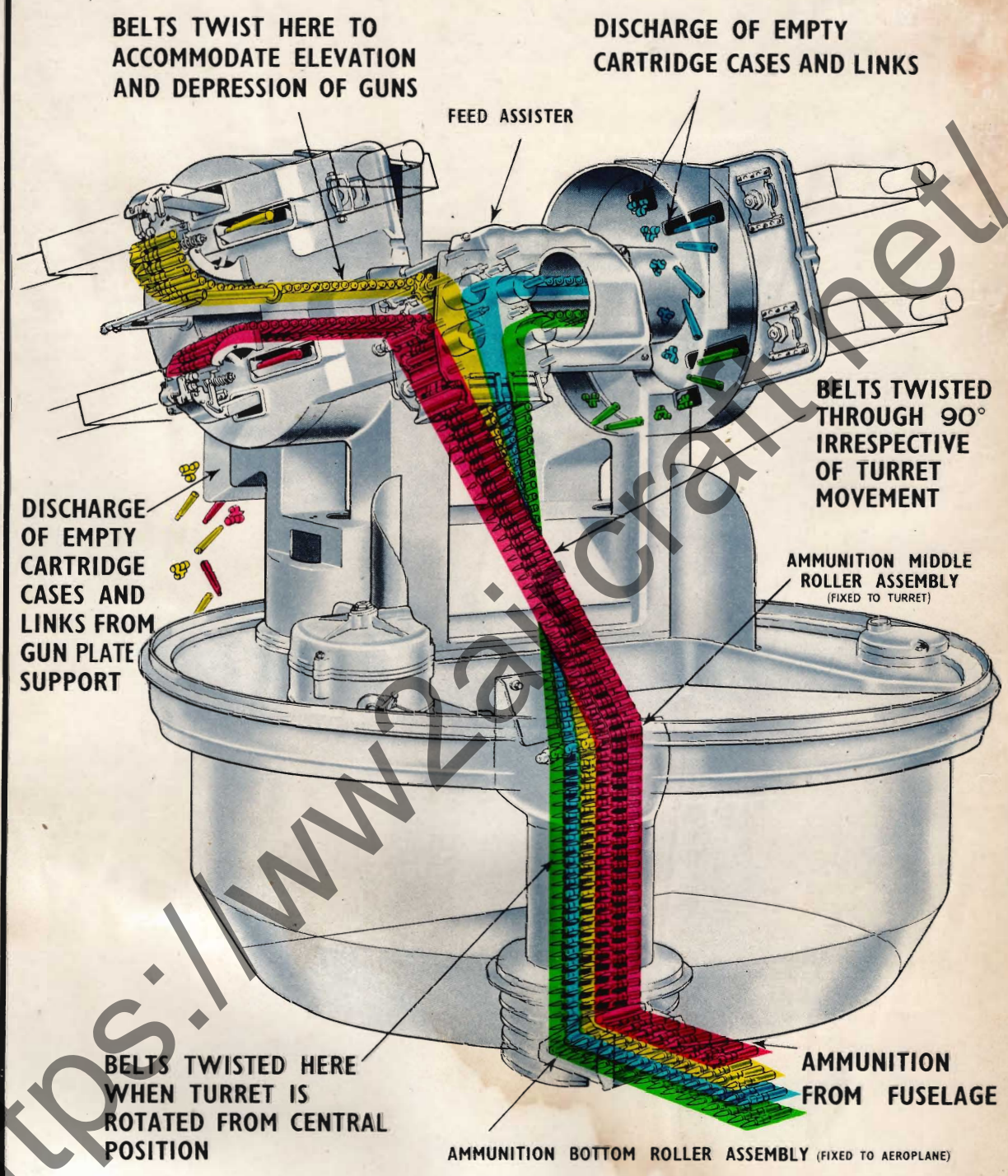
(v) Each gun is fitted with a firing solenoid, bracket, top plate and tappet.

(vi) Suitable feed, link and empty cartridge case chutes are fitted to each gun.

(vii) The guns are not fitted with a blast tube, as most of the barrel and casing of the gun projects out of the gun turret and is exposed to the air stream.

BOULTON AND PAUL TYPE "C" TURRET (HUDSON)

http://www2aircraft.net/


BELTS TWIST HERE TO ACCOMMODATE ELEVATION AND DEPRESSION OF GUNS
DISCHARGE OF EMPTY CARTRIDGE CASES AND LINKS
FEED ASSISTER
BELTS TWISTED THROUGH 90° IRRESPECTIVE OF TURRET MOVEMENT
DISCHARGE OF EMPTY CARTRIDGE CASES AND LINKS FROM GUN PLATE SUPPORT
AMMUNITION MIDDLE ROLLER ASSEMBLY (FIXED TO TURRET)
BELTS TWISTED HERE WHEN TURRET IS ROTATED FROM CENTRAL POSITION
AMMUNITION FROM FUSELAGE
AMMUNITION BOTTOM ROLLER ASSEMBLY (FIXED TO AEROPLANE)

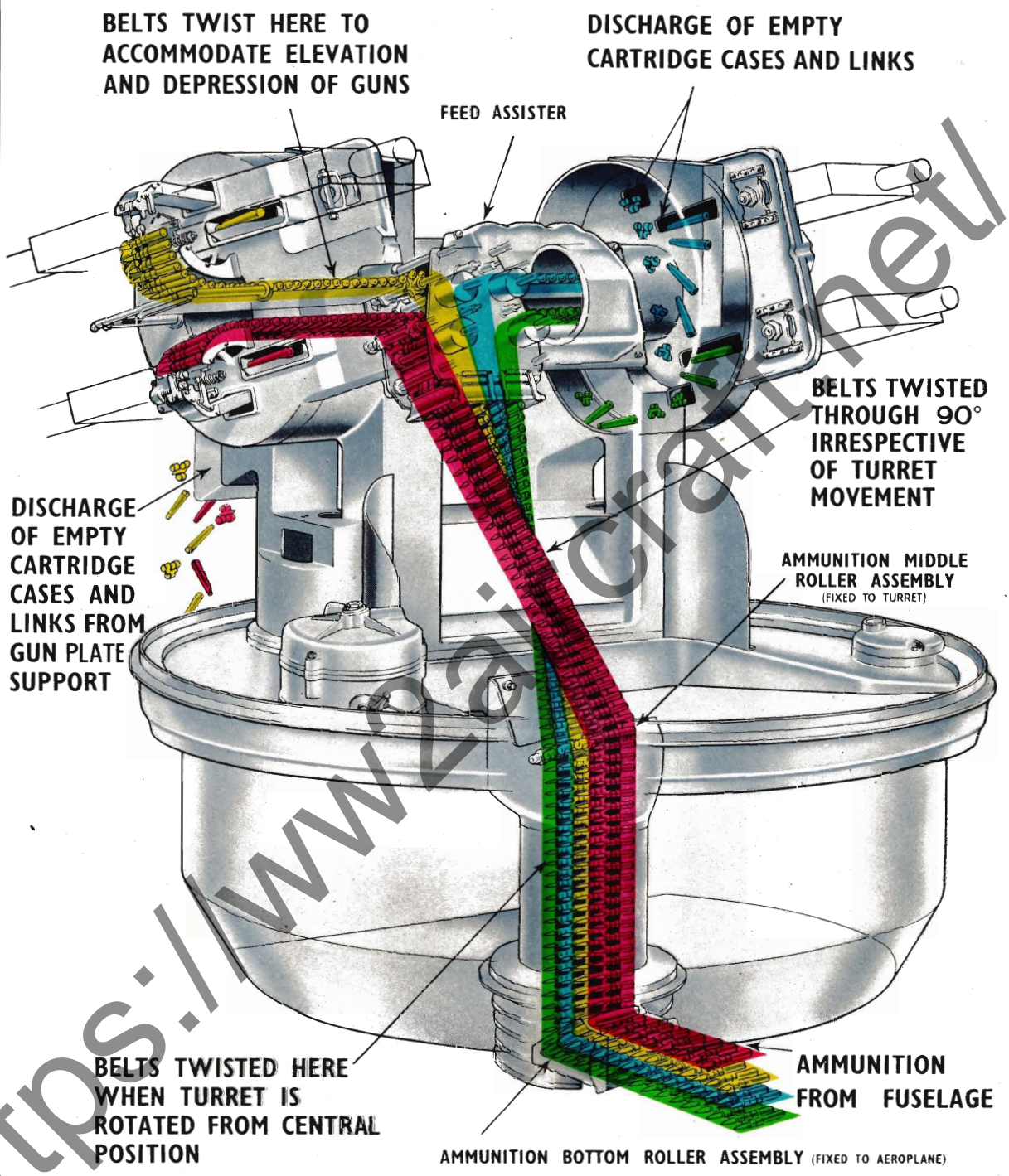
AMMUNITION SYSTEM

GUN TURRETS.

B.P., Type E. Mk. I and II

For further information see A.P. 1659 C. Vol. I and Vol. II

https://www.2aircraft.net/


BELTS TWIST HERE TO ACCOMMODATE ELEVATION AND DEPRESSION OF GUNS
DISCHARGE OF EMPTY CARTRIDGE CASES AND LINKS
FEED ASSISTER
BELTS TWISTED THROUGH 90° IRRESPECTIVE OF TURRET MOVEMENT
DISCHARGE OF EMPTY CARTRIDGE CASES AND LINKS FROM GUN PLATE SUPPORT
AMMUNITION MIDDLE ROLLER ASSEMBLY (FIXED TO TURRET)
BELTS TWISTED HERE WHEN TURRET IS ROTATED FROM CENTRAL POSITION
AMMUNITION FROM FUSELAGE
AMMUNITION BOTTOM ROLLER ASSEMBLY (FIXED TO AEROPLANE)

AMMUNITION SYSTEM

GUN TURRETS.

B.P., Type E. Mk. I and II

For further information see A.P. 1659 C. Vol. I and Vol. II

https://www.aircraft.net/